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# Studies on the fossil woods from the Tertiary of Japan

## I. Fossil woods from the River Mabeti, Anatai Village, Ninohe District, Iwate Prefecture<sup>(1)</sup>

By Shunji WATARI

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With 7 figures and 3 photographs in the text

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(Received June 30, 1941)

The river Mabeti comes from the Kitakami Mountains and streams towards north, finally emptying into the Pacific Oceans near Hatinoh City, Aomori Prefecture. About forty-five km. distant from the mouth of the river, two branches, the river Nesori and the river Hiranuka, join to the river Mabeti. Along these three rivers, numerous fossil woods expose, lying or erecting, from the original rocks of the river bed and the river sides.<sup>(2)</sup> Recently, these areas were protected by law as the natural monument. In June 1940, the writer fortunately has had an opportunity to visit there to collect numerous materials. At the river Mabeti, fossil woods are especially abundant at Sitamura and Samuraimura, Anatai Village; the present paper reports the internal structure of about twenty materials obtained there.

The weathering surfaces of these fossil woods found at Anatai Village are usually grayish, and the surface newly broken, dull black in colour. The preservation of internal structures is generally rather poor. Nearly all walls are deep black in colour and receive innumerable cracks, so as, in most parts to be unable to observe in no details, while in some fragments details in structure are rather excellently preserved. Thus in most materials the characteristic features have sufficiently been observed. There are, though rarely, exceptionally well-preserved materials in which nearly all walls show brown in colour and suffer no cracks (e.g. No. 31135). On the other hand there are several materials whose structures are actually impossible to observe.

The cracked walls of these materials seems to more or less cabornized, and the lumens are filled with hard silicified medium. This peculiar

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(1) Contributions from the Divisions of Plant-Morphology and Genetics, Botanical Institute, Faculty of Science, Tokyo Imperial University, No. 276.

(2) Corresponds to the lower part of the Miocene. (OTUKA 1934).

preservation of the fossil woods seems to attribute to the "versteinerte Holzkohle", which were termed by GOTHAN (1908) on some fossil woods from the Lower Cretaceous of König Karls Land, Norway. He wrote as follows:—"Einen recht interessanten Erhaltungszustand bietet ein Stück... Es könnte als versteinerte Holzkohle bezeichnet werden..." (p. 6). "Besonders instruktiv ist der Querschliff. Hier erkennt man unschwer, dass die Zellwände als Kohlschwarze Substanz erhalten sind, deren Zwischenräume durch farblose Kieselsäure ausgefüllt sind.... Der holzkohlige Zustand muss schon vor der Versteinering fertig vorhanden und das Holz in diesem Zustande eingebettet worden sein. Holzkohle ist ein chemisch ausserordentlich resistenzfähiger Körper, und so wurden die in Holzkohle umgewandelten Zellmembranen nicht weiter affiziert, als später sich die Lücken zwischen den Zellenwänden mit Versteinungsmasse—die übrigens hier fast stets farblose ist—ausgefüllten" (p. 7).

Among these fossils, are determined the following six species, a coniferous and five dicotyledonous woods:—

<i>Pinoxylon mabetiense</i> sp. nov.	8 examples
<i>Juglandinium</i> sp.	1 "
<i>Quercinium anataiense</i> sp. nov.	4 "
<i>Ulmium zelkowiforme</i> sp. nov.	1 "
<i>Laurinium machiliforme</i> sp. nov.	1 "
A dicotyledonous wood	1 "

Preceding to enter the descriptions, I wish to express my heartfelt thanks to em. Prof. T. WAKIMIZU and Prof. T. NAKAI of the Tokyo Imperial University at whose suggestion and courtesy I have had the opportunity to visit the districts. I am also indebted to Mr. G. TOBA of the Iwate Normal School and others under whose cordial guidance I have obtained many valuable materials. To Prof. Y. OGURA who gave many preceous criticisms and suggestions throughout the whole course of my present study, I wish to express my sencere thanks.

\* \* \*

### *Pinoxylon mabetiense* sp. nov.

(Figs. 1, 2; Photo. 1, 2 A-C)

**Materials.** No. 31127; a huge trunk lying on the river bed; 160 cm. in diameter and 11 m. in length; collected at Sitamura; preservation is generally poor, but in some parts, pits on the tangential and the lateral walls of medullary rays are excellently preserved. Nos. 31128 (50 cm. in diameter and 4 m. in length), 31131 (30 cm. in diameter), 31132 (30 cm. in diameter), 31134 (60 cm. in diameter); all lying on the river bed at Samuraimura; preservation poor. No. 31135; a decorticated wood about 30 cm. in diameter and 30 cm. in length, lying on the river bed; collected at Samuraimura; preservation, excellent; the following description is chiefly based on this specimen. Nos. 31139, 31143; both lying on the river bed; collected at Samuraimura; preservation, rather poor.



## Description

*Growth rings* are well-marked; breadth is variable, measuring 0.2–3.0 mm., mostly 0.5–2.5 mm.; the transition from the early to the late wood is various, usually abrupt, sometimes gradual (Photo. 1 A–C). *Tracheids* of the early wood are fairly large, thin-walled, squarish and

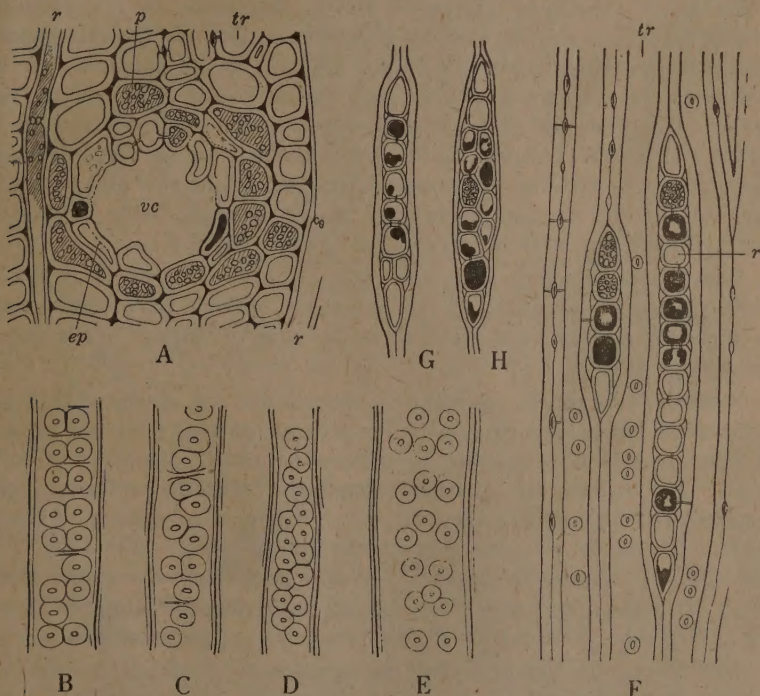


Fig. 1. *Pinoxylon mabetiense* sp. nov. A, transverse section of a part of wood showing details of a vertical resin canal and simple pits on the horizontal walls of a ray. B–E, various cases of the arrangement of bordered pits on the radial walls of tracheids of the early wood. F, tangential section of a small part of the late wood showing two medullary rays and pitting on the tangential walls of tracheids. G, H, two examples of partly biseriate rays in tangential section. *tr*, tracheid; *vc*, vertical resin canal; *p*, wood parenchyma; *ep*, epithelial cells; *r*, medullary ray. ( $\times 220$ ).

are elongated in radial direction, measuring 30–60  $\mu$  in radial, 20–50  $\mu$  in tangential diameter (Photo. 1 C); bordered pits on the radial walls are usually arranged in one or two, very rarely in three rows, circular in outline, their arrangement being contiguous or separated and when

more than two rows usually opposite and contiguous or separated, sometimes alternate and contiguous. In the last case they are often hexagonal by mutual contact. They are  $1/2-1/4$  of the tracheid width in diameter; pit-openings are small, circular or oval in outline; bars of SANIO are often present, being straight or slightly curved; there are no pits on the tangential walls (Fig. 1 B-E, 2 A; Photo. 1 D). Late wood is rather narrow, 3-30 cells or rarely more thick, mostly corresponding to  $1/2-1/5$  of the whole increment (Photo. 1 A-C); tracheids are thick-walled, flattened and squarish with rounded corner in outline and the intercellular spaces are sometimes distinct (Photo. 1 C, 2 A); the bordered pits on the radial walls are arranged in one row and separated from one another, circular in outline; the pits-openings are lenticular, placed vertically or nearly so (Fig. 2 A); bars of SANIO are indistinct; rather large bordered pits on the tangential wall are present, arranged in one row and separated from one another, circular in outline, the pit-openings being vertical or slightly oblique and oval or lenticular in shape (Fig. 1 F).

*Wood parenchyma* occurs on the periphery of growth rings in vicinity of the resin canals. It is frequently resinous; horizontal walls are thickened and densely pitted as in the case of the end walls of ray parenchyma (Photo. 2 A).

*Vertical resin canals* are rather numerous and are scattered throughout the wood, disposing singly, or two to several (at most five) in a tangential band, rarely a few being in oblique or radial directions (Photo. 1 A-C). The canals are circular, sometimes radially or tangentially elongated oval in outline; they are much variable in diameter, mostly  $30-150 \mu$ , larger canals occurring chiefly in the early wood (Fig. 1 A; Photo. 1 A-C). Epithelial tissue is 1-3 cells thick; cells are rather thick-walled, strongly pitted and often project into the cavity of the canals (Fig. 1 A, 2 A). Thin-walled thyloses seem to appear occasionally.

*Medullary rays* are uniseriate or occasionally biseriate in part, the fusiform rays being entirely absent; 1-11, mostly 2-7 tracheids in intervals; 1-36, mostly 2-13 cells high, and 27-37 in 1 square mm. In tangential section the ray cells are roundish or rectangular with rounded corners in shape and have distinct triangular intercellular spaces (Fig. 1 F-H; Photo. 1 E, 2 C). In some rays all elements are apparently parenchymatous, often containing resinous substances. All walls are pitted; horizontal walls are slightly thickened and pits are small, circular, simple and arranged in one or two, more or less irregular rows; tangential walls are much thickened and are placed at a rather variable angle, pits being simple, small and numerous (Fig. 1 F-H; Photo. 2 C); pits into the early wood tracheids are small and appear to be simple in some cases but usually are apparently half-bordered with large oval or



elliptical pit-openings; they number one to five, mostly two to four per cross field (Fig. 2 A-C; Photo. 2 B); those into the late wood tracheids, with lenticular or slit-like pit-openings, one or two per cross field (Fig. 2 A). In other rays there occur marginal elements suggesting the

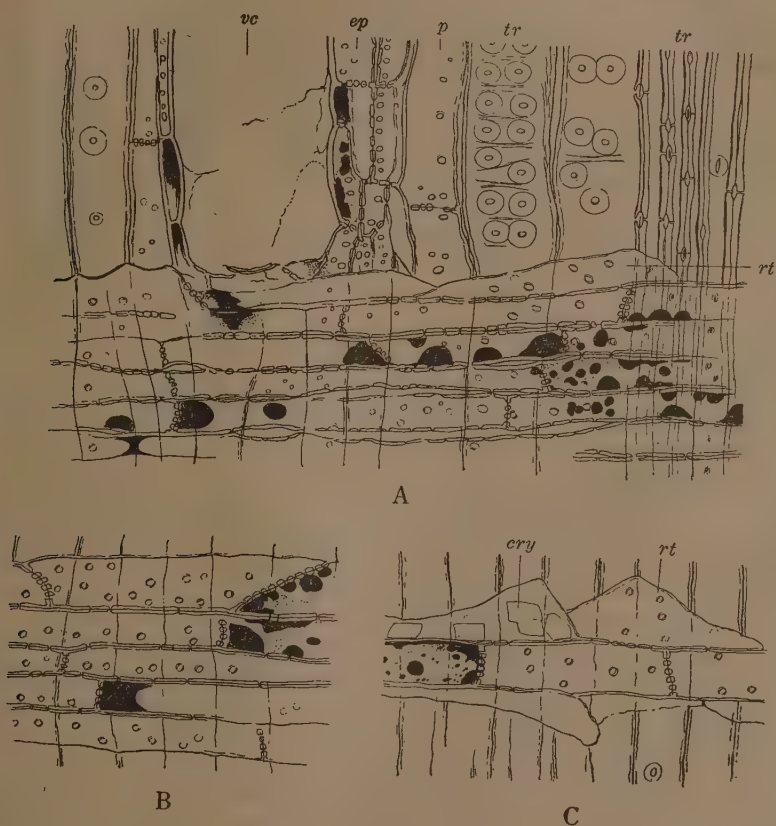


Fig. 2. *Pinoxylon mabetsiense* sp. nov. A, radial section of a small part of wood, containing a vertical resin canal and a medullary ray. B, radial view of a small medullary ray consisting only of ray parenchyma. C, radial view of a medullary ray of three cells high, marginal elements showing the nature of ray tracheid (rt) and bearing crystals (cry). Abbreviations as in Fig. 1. ( $\times 220$ ).

ray tracheids (rt in Fig. 2 A, C): often considerable number of such elements are arranged in a radial series, but occasionally only a single or a few in number; all walls are thin, and the margin is frequently irregular; the pits on the lateral walls seem to be the same as in the

case of typical ray parenchyma and those on the tangential walls are indistinct; occasionally several rhomboidal crystals are contained (Fig. 2 C; Photo. 2 B).

### Affinity

From the foregoing description it is clear that the present fossils are an abietinean wood, and the most important feature in the identification is in the presence of only the vertical resin canals. No living conifers have such a characteristic excepting a pinaceous genus *Keteleeria* (KANEHIRA 1921, 1926; BAILEY 1933) and the general features of wood of *Keteleeria Davidiana* show a considerable resemblance with the present materials, especially in the presence of thin-walled marginal elements of the medullary rays, often showing irregular form and occasionally containing crystals in them, but it apparently differs in that, in *Keteleeria*, the bordered pits on the lateral walls of the tracheids are often arranged in four rows, the rays are relatively low, and the resin canals are usually very small in diameter (20–70  $\mu$ ).

Among the fossil conifers, however, several species showing such characteristics have been described under the generic name *Pinoxylon* or *Protopiceoxylon*. *Pinoxylon* is a genus established by KNOWLTON with a brief generic diagnosis; "internal structure of the wood same as in *Pinus*, except in the absence of fusiform rays", and he described a species *P. dakotense* from the Lower Cretaceous of South Dakota (1900, pp. 420–422). *Protopiceoxylon* is a genus established by GOTHAN who described a single species *P. extinctum* from the Lower Cretaceous of König Karls-Land, Norway (1908, pp. 32–36)<sup>1)</sup>.

GOTHAN stressed the importance of the normal occurrence of the vertical resin canals in describing "... , es sind daher die Harzgänge als wesentliche, ständige Merkmale unseres Holzes anzusehen" (p. 33) and criticized the KNOWLTON's description on *Pinoxylon* as follows; "Auch dieses Holz hat nach KNOWLTON nur verticale Harzgänge; die Bedeutung dieses Umstandes scheint aber KNOWLTON nicht erkannt zu haben" and "Leider sich aus seinen Mitteilungen nicht entnehmen, ob die Harzgänge reguläre Bildungen sind oder auf Wundreiz sich zurückführen lassen". (p. 35). SEWARD (1919) stated the same opinion and added "*Piceoxylon* would seem to be the more appropriate designation for KNOWLTON's species" (p. 232). In his original description, however, KNOWLTON described; "The resin passages, however, are present and quite numerous. They do not seem to be confined to any particular portion of the ring, but are scattered, being, perhaps, most abundant in the fall wood" (p.

(1) In 1910, GOTHAN again reported the occurrence of the same species from Spitzbergen.



420), and in other part, "....., our wood has distinct resin passages, but is without the fusiform rays" (p. 422). From these passages it seems to be rather appropriate that one regards the resin canals in *Pinoxylon* as the 'normal type', though he used neither such term nor 'normal wood'.

In comparing these two genera, READ (1933) wrote; "*Pinoxylon* differs from *Protopiceoxylon* only in the presence of *Holzparenchym* (p. 179), and, in considering WALTON's suggestion (1927) on the presence of parenchyma in GOTHAN's species, he has come to the conclusion; "*Pinoxylon* becomes the correct generic designation for the species which have been referred to GOTHAN's genus" (p. 179). He carefully reexamined KNOWLTON's type specimen and redescribed the generic and specific diagnosis, and transferred the species described under the name *Protopiceoxylon* to *Pinoxylon*. His generic diagnosis is as follows:—

"Annual rings, present, usually well marked. Resin canals, vertical canals normal; horizontal system absent or developed as a result of injury; epithelial cells thin or thick-walled, variable. Wood rays, uniseriate or partly biseriate, variable in size. Fusiform rays absent except in traumatic areas; pitting abietinean, that is, abundant on all walls; marginal ray cells modified into elements resembling ray tracheids, or undifferentiated. Resin abundant. Wood parenchyma, absent or present; when the latter, diffuse or terminal. Tracheids, bordered pits radial in early wood; radial, or radial and tangential in late wood of ring. Pitting in part opposite and separate and in part alternate and contiguous. Medulla, variable; often sclerotic."

From the foregoing description that my present specimens should be included in this category is apparent.

Regarding to the affinities<sup>(1)</sup> of *Pinoxylon*, KNOWLTON (1900) mentioned "undoubted resemblance to *Pinus*" (p. 422), while GOTHAN (1908) pointed out the impropriety of KNOWLTON's opinion and placed his *Protopiceoxylon* nearest to *Piceoxylon*. BAILEY (1933) wrote; "In any case, it is evident that *Protopiceoxylon* falls within the range of structural variability of *Keteleeria*, not only as regards the peculiar distribution of its resin canals, but also as concerns its tracheary pitting, tori, bars of SANIO, rays, and other structural features" (p. 152), and concluded; "*Protopiceoxylon* obviously is not an Araucarian Conifer. It is an extinct Protopinaceous genus, transitional between *Cedroxylon* and *Piceoxylon*" (p. 151).

In many species of *Pinoxylon* or *Protopiceoxylon*, the presence of crystal-bearing marginal elements of the medullary rays was never described. Occurrence of such cells in the present specimen, however, must be noted in connexion with the fact that the rhombic crystals are found

(1) On other various opinions concerning the affinities of *Protopiceoxylon* or *Pinoxylon*, see EDWARDS (1925), READ (1932), SHIMAKURA (1936, 1937).

in the marginal elements of certain species of *Abies*, *Cedrus*, *Pseudolarix* and *Keteleeria* (WIESEHUEGEL 1932, CHRYSLER 1915, BARGHOORN and BAILEY 1938, KANEHIRA 1926). Such elements in *Piceoxylon transiens* are also reported (SHIMAKURA 1937).

*Pinoxylon dakotense* KNOWLTON em. READ shows a considerable resemblance with the present specimen in the distribution and size of the resin canals, the thickness of the epithelial tissue, the presence of the suggestive ray tracheids, but differs in the intensive development of the late wood (forming as much as half the increments), the usual occurrence of two patterns of the pits arrangement on the radial walls of tracheids, i.e. "(1) distant and if more than uniseriate, opposite" and "(2) contiguous and alternate, the borders flattened" (p. 175), the latter being rather rare in the present specimen. It is also different in the height of rays (1-26, usually 4-12 cells high), and in the occurrence of a small quantity of the diffuse parenchyma. A fossil wood from the Lower Cretaceous(?) of Féng-tien Province, Manchoukuo, which was described by SHIMAKURA (1937) under the name *Pinoxylon dakotense*, seems to slightly differ from READ's diagnosis, e.g. in the absence of the diffuse parenchyma and in the rare occurrence of the alternate arrangement of the bordered pits, these respects rather resembling to my fossil. But the height of rays agrees with READ's description.

*Protopiceoxylon extinctum*, the type of *Protopiceoxylon*, is a species that shows considerable agreement with the present fossil in the arrangements of the bordered pits and the presence of marginal elements suggesting the ray tracheids, but according to EDWARDS's observation on GOTHAN's specimen from König Karls-Land (1925), the pitting in three rows seems to occur frequently. It seems also to differ in some other respects. In the original description the entire absence of parenchyma is noted though the presence of terminal parenchyma is suggested by WALTON (1927).

*Protopiceoxylon Johnseni* (SCHROETER) GOTHAN (SCHROETER 1880, GOTHAN 1910) differs greatly from the present fossil in the intensive development of the late wood, smaller number of resin canals, the presence of a small quantity of the diffuse parenchyma, the occurrence of contiguous bordered pits arranged in a single row, and also in the rays are considerable lower (1-18 cells high).

*Protopiceoxylon salisburyoides* KRAUSEL (1913) is a species from the Braunkohl of Germany. But a rigid comparison with my fossil seems to be difficult owing to brief description without figures.

*Protopiceoxylon Edwardsii* STOPES from the Greensand of Sussex, England (STOPES 1915) and Dunnose, Isle of Wight, England (EDWARDS 1925) also apparently differs in the usual occurrence of a single row of



the tracheary pitting, the lower rays (1–20, mostly 3–8 cells high), the absence of the ray tracheids, the occurrence of a small quantity of the diffuse parenchyma, and in the smaller size of the vertical resin canals with only four or five epithelial cells.

*Protopiceoxylon Lindlei* (WITHAM) ECKHOLD (WITHAM 1831, 1833; ECKHOLD 1922) from the Triassic of Yorkshire, England, is also distinctly distinguished from the present specimen. The rays are usually low (1–12 cell high) and the tracheary pitting is, as usual, alternate and hexagonal.

*Protopiceoxylon arcticum* SEWARD (1919) is a species from the Oxfordian (probably) of Franz Josef Land. The rays are higher in average (20–30 cells high), the terminal parenchyma is absent, and the pits on the cross fields are numerous (four or five).

*Protopiceoxylon Wordii* WALTON (1927) from the Middle Jurassic of West Spitzbergen shows some resemblance but the horizontal walls of the ray parenchyma are very thick and densely pitted (fig. 5) and no ray tracheis are suggested.

*Pinoxylon Yabei* SHIMAKURA (1936) from the Jurassic of Manchoukuo (1936) quite differs in the ray height (1–70 cells).

As compared above there are no species which show an identity with my present specimen. Moreover, all of them are of the Mesozoic origin excepting a species, *P. salisburyoides* which is imperfectly described. It is believed thus, that the present specimen may be a new type of *Pinoxylon* or *Protopiceoxylon*, and in the present paper the generic name *Pinoxylon* KNOWLTON em. READ is preferred according to READ's opinion. A special interest of the present fossil, however, is referred in the respect that the specimens were collected from the strata where several dicotyledonous woods, distinct indicatives of the Tertiary age, are found together.

## Diagnosis

### *Pinoxylon mabetiense* sp. nov.

Abietinean wood with vertical resin canals only. Growth rings well marked, breadth various; transition from early to late woods abrupt or gradual; late wood rather narrow, usually 3–30 cells thick or  $1/2$ – $1/5$  of the whole increment. Tracheids of early wood squarish or radially elongated rectangular in outline, thin-walled; bordered pits on radial wall usually circular with relatively small pit-openings,  $1/2$ – $1/4$  of tracheid width in diameter, arranged usually in one or two, rarely three rows and when more than two rows, usually opposite and separate or slightly contiguous but occasionally alternate and sometimes hexagonal by mutual contact; bars of SANIO frequently distinct. Tracheids of late

wood thin-walled, flattened and squarish or polygonal with rounded corner in outline; intercellular spaces sometimes distinct; bordered pits on radial wall circular with lenticular and vertical or slightly oblique pit-openings, arranged in one row and separated, bars of SANIO indistinct; bordered pits on tangential wall present, rather large, circular with lenticular and vertical pit-openings. Wood parenchyma terminal and in vicinity of canals, horizontal walls thickened and pitted. Resin canals only vertical at least in normal wood, rather numerous, scattered throughout the wood, disposed singly or grouped; canals round or elliptical and variable in diameter; epithelial tissue thick-walled, 1-3 cells thick. Medullary rays uniseriate or biseriate in part; 1-11 tracheids in intervals; 1-36, mostly 2-13 cells high, 27-37 per 1 mm. square; horizontal walls slightly thickened and pitted; tangential wall very thick, densely pitted, vertical, oblique or slightly curved; pits on cross field half-bordered or sometimes simple (?), one to five, mostly two to four in early wood and one or two in late wood; frequently marginal elements suggesting ray tracheids present, all walls thin, margin frequently irregular and occasionally bearing rhomboidal crystals.

From Samuraimura and Sitamura, Anatai Village, Ninohe District, Iwate Prefecture; the lower half of the Miocene; collected by S. WATARI in 1940; Nos. 31127, 31128, 31131, 31132, 31134, 31135, 31139, 31143.

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Photo. 1. *Pinoxylon mabetsiense* sp. nov. A, transverse section; growth rings are narrow in breadth and transition from the early to the late wood is abrupt; there scatter numerous vertical resin canals. ( $\times 20$ ). B, transverse section; growth rings are rather broad and transition is somewhat gradual; there are several large vertical canals. ( $\times 20$ ). C, transverse section showing the shape and the arrangement of tracheids and details of resin canals. ( $\times 80$ ). D, radial section of the early wood, showing various types of arrangement of the bordered pits on the radial walls of tracheids. ( $\times 120$ ). E, tangential section of the early wood; all rays are uniseriate or biseriate in part. ( $\times 80$ ).



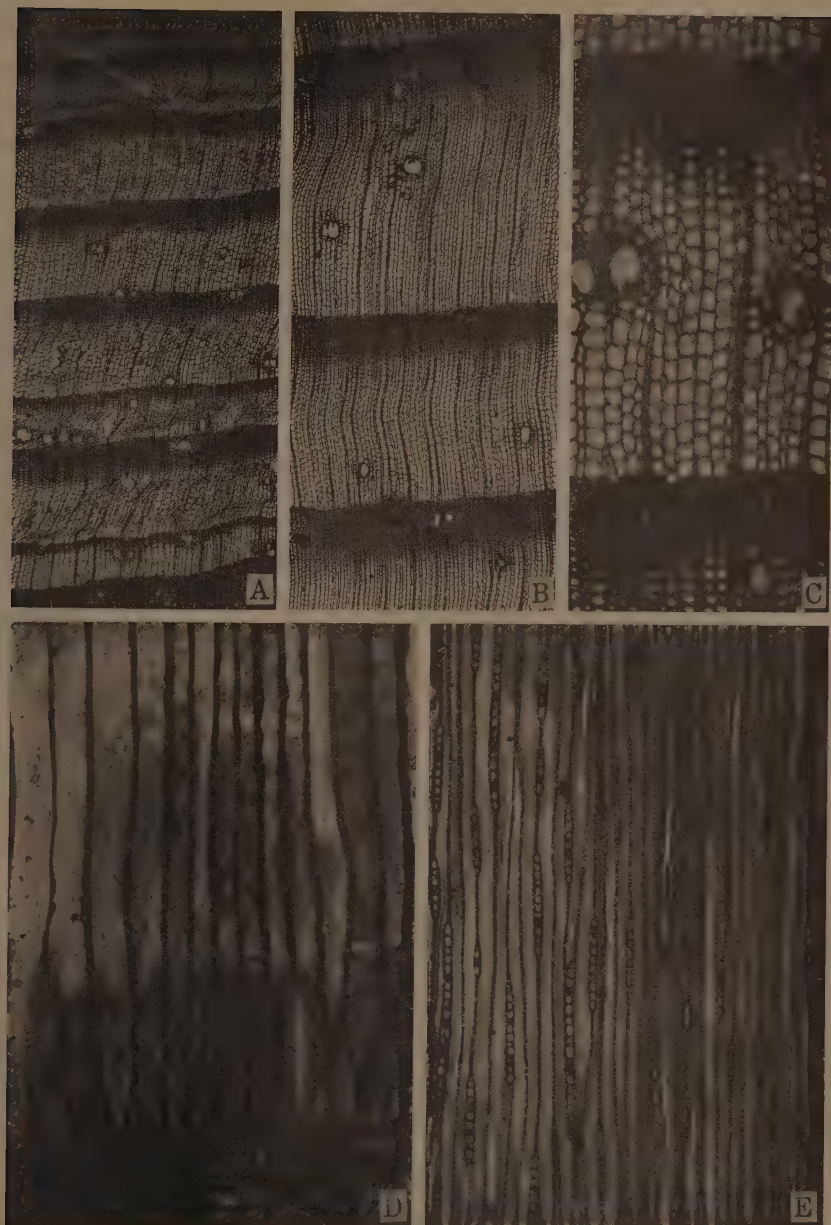


Photo. 1



Photo. 2



*Juglandinium* sp.

(Fig. 3)

**Material.** No. 31138; a small decorticated wood lying on the river bed,  $6 \times 7$  cm. in diameter, 13 cm. in length; collected at Samuraimura; preservation is poor.

**Description**

Boundaries of *growth rings* are faintly marked by the arrangement of vessels; the breadth varies 0.8–4.0 mm., mostly 3.0–3.5 mm. *Vessels* are diffused, gradually diminishing their size towards the late wood, round or radially elongated oval in outline, and are disposed solitary or two or three, rarely four in radial series, arranging as a whole diagonally (Fig. 3 A). They measure mostly  $150\text{--}250\ \mu$ , sometimes more than  $300\ \mu$  in diameter, the smallest in the late wood being  $15\ \mu$ . In 1 square mm., number two to seven, mostly three to six vessels in the early wood, and seven to fifteen in the late wood. Vessel segments vary  $110\text{--}450\ \mu$ , mostly  $180\text{--}300\ \mu$  in length; end walls are placed slightly obliquely and perforations are apparently simple. Pits on lateral walls are bordered with round or horizontally oval openings, alternate or opposite in arrangement, measuring  $7\text{--}10\ \mu$  in diameter. There are no spiral thickenings. Thin-walled thyloses occur in some vessels.

Metatracheal and vasicentric *parenchyma* is apparently present and a small quantity of diffuse parenchyma seems to be also present. Metatracheal parenchyma is arranged in a very characteristic manner, that is, in very distinct tangential, or often, especially in the early wood, in somewhat diagonal bands of one or two cells thick (*p* in Fig. 3 A). In longitudinal section each cell is connected in vertical series, one to several cells in the median part of which are often very large, each containing

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Photo. 2. *Pinoxylon mabetiense* sp. nov. (A–C). A, transverse section of a part of boundary of growth rings, showing a terminal parenchyma with densely pitted horizontal wall, thin-walled tracheids of the early wood, and very thick-walled tracheids of the late wood. ( $\times 400$ ). B, radial section showing a crystal-bearing marginal element suggesting the nature of ray tracheid, pittings on the cross-field, and several bordered pits on the radial walls of the early wood tracheids. ( $\times 400$ ). C, tangential section of a part of an uniseriate ray; shape of elements, triangular intercellular spaces and the abietinean pitting on the tangential wall are clear. ( $\times 1000$ ).

*Quercinium anataiense* sp. nov. (D–G). D, transverse section of wood showing the arrangement of vessels and the presence of broad rays. ( $\times 10$ ). E, transverse section of a small part of wood; large vessels in the early wood are elongated radially and small vessels in the late wood, tangentially. ( $\times 40$ ). F, palisade-like pitting between a vessel and ray parenchyma. ( $\times 400$ ). ( $\times 400$ ). G, tangential section showing vessels with marked thyloses, a few uniseriate rays (middle) and a part of broad ray (left). ( $\times 80$ ).

a large polygonal figure suggesting simple crystal (Fig. 3 D). Each cell measures  $10-30\ \mu$  in diameter and  $40-100\ \mu$  in length, and the large, crystal-bearing one is usually isodiametric and  $30-60\ \mu$  in diameter. Vasicentric parenchyma varies  $8-30\ \mu$  and  $25-40\ \mu$  in diameter and length respectively.

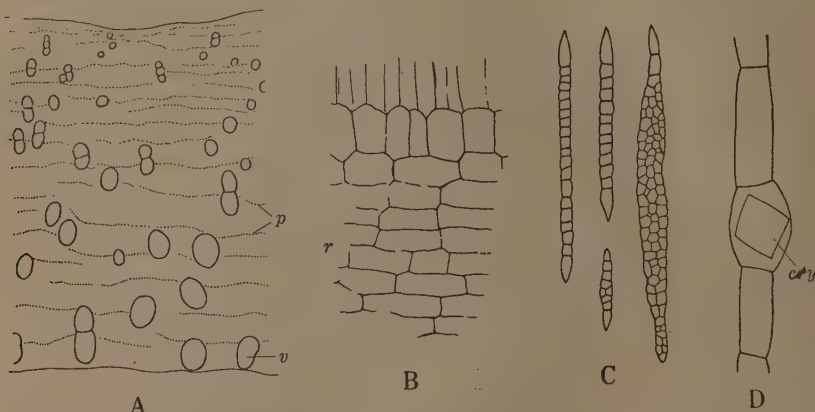


Fig. 3. *Juglandinium* sp. A, a schema of the whole increment of a growth ring showing the arrangement of vessels and tangential bands of metatracheal parenchyma (in dotted lines). B, radial view of a part of heterogeneous medullary ray. C, four examples of medullary rays in tangential section. D, longitudinal view of a part of parenchyma series, including a crystal-bearing cell. v, vessel; p, wood parenchyma; r, medullary ray; cry, crystal. (A,  $\times 16$ ; B, D,  $\times 220$ ; C,  $\times 80$ ).

Areas between the parenchyma bands are mostly destroyed, but on some parts, the nature of *wood fibres* or *tracheids* are suggested though they are very poor in preservation. Individual elements are polygonal in outline, rather irregular in arrangement and  $8-20\ \mu$  in diameter, further details being obscure.

*Medullary rays* number six to ten in breadth of 1 mm., 1-3, rarely 4 cells broad, 3-35 cells or  $80-600\ \mu$  high. Rays are mostly heterogeneous but sometimes homogeneous; in tangential section the median cells are round, and the marginal cells are narrow to broad oval in shape (Fig. 3 C); in radial section the median cells are procumbent,  $25-50\ \mu$  in length by  $15-30\ \mu$  in height, while the marginal ones are procumbent to upright,  $15-50\ \mu$  in length by  $30-50\ \mu$  in height (Fig. 3 B). Ray cells are thin-walled; the pits between them are obscure; those into vessels are small, oval in outline, alternate or opposite in arrangement, and  $4-7\ \mu$  in diameter.



### Affinity

From the description described above, the present material must be a dicotyledonous wood. In its identification the following respects seem to be very important, that is, the distinct diagonal arrangement of vessels with gradual diminishing of their size towards the periphery of a growth ring, the largeness of vessel size—often reaching more than  $300\mu$ , the fact that they dispose solitarily or in short radial series, the simple perforation on the end wall of vessel segments, the presence of alternate or opposite, round or oval bordered pits on the lateral walls of vessel, the absence of the spiral thickenings, the occurrence of very distinct tangential bands of the metatracheal parenchyma, and the presence of the heterogeneous, sometimes homogeneous, medullary rays of one to three, rarely four cells wide. From these characteristics it is clear that the present fossil comes nearest, among the living plants, to *Juglans* of the Juglandaceae (KANEHIRA 1926, RECORD 1919, YAMABAYASHI 1938, HEIMISCH and WETMOORE 1938). Among many species of this genus, it seems to especially resemble to *J. Sieboldiana*, but a rigid comparison is actually impossible owing to the poor preservation of the material.

Several fossil woods of juglandaceous plants have been reported since the Upper Cretaceous under the generic names *Juglandinium*, *Jugloxylon*, *Juglansoxylon* and *Juglans* by several authors (EDWARDS 1931). Many of these species seems to differ from my present fossil. This specimen may be a new species, but the writer hesitates a little to describe it under a new name, according to a imperfectness of the material.

### *Quercinium anataiense* sp. nov.

(Figs. 4, 5; Photo. 2 D-G)

**Materials.** No. 31129; a large trunk about 40 cm. in diameter and 4 m. in length; preservation is poor. No. 31130; a large trunk about 40 cm. in length; preservation is generally poor, but is tolerably good in small parts. No. 31133; a large trunk about 1 m. in diameter and more than 5 m. in length; preservation is the same as in the case of No. 31130. No. 31142; a large trunk less than 30 cm. in diameter; preservation is poor.

**Note:**—All materials lying on the river bed; collected at Samurai-mura, Anatai Village. The following description is chiefly based on Nos. 31130 and 31133.

### Description

Boundaries of *growth ring* are distinct by the disposition of vessels and the presence of several layers of somewhat flattened elements; the breadth of rings varying 1.0–2.5 mm. (Photo. 2 D, E). *Vessels* in the

early wood are large, mostly round or slightly elongated radially in outline and are arranged in one or two tangential rows, measuring 180–400  $\mu$ , mostly 250–320  $\mu$  in diameter; those in the late wood are small, round or slightly elongated tangentially, radial, oblique radial or flame-like in arrangement, and 40–200  $\mu$ , mostly 80–140  $\mu$  in diameter (Fig. 4; Photo. 2 D, E); in 1 square mm., they number four to nine in the early wood and nine to eleven in the late wood. All vessels are scattered singly. Their walls are relatively thin. Vessel segments mostly measure 90–410  $\mu$  in length; end walls are placed horizontally or slightly obliquely; perforations are apparently simple; pits on the lateral walls are numerous, alternately arranged, round or laterally elongated elliptical in outline, 7–10  $\mu$  in diameter, and apparently bordered with horizontal flattened elliptical openings (Fig. 5 A). In the transverse section the thin-walled thyloses are found here and there, but in the longitudinal section it is known that they occur very abundantly (*t* in Fig. 5 A; Photo. 2 F).

*Tracheids* are abundantly present, but in transverse section they are difficult to discern from the wood fibres; they measure 15–30  $\mu$  in diameter and are apparently long fusiform, but their length can not accurately be measured owing to the bad preservation. Pits on the lateral walls are small, round, apparently bordered with round or elliptical openings and 6–8  $\mu$  in diameter; they are arranged in one or two alternate rows (*tr* in Fig. 5 C).

*Wood fibres* appear at a glance not so thick-walled in the preparation, but it apparently owes to the state of preservation because in some parts the original thick-walled state is faintly discernible. They are especially abundant in the late wood; 8–20  $\mu$  in diameter, but their length is uncertain. Pits on the lateral walls small, round in outline, and are arranged in one row, pit-openings being not clear (*f* in Fig. 5 D).

*Wood parenchyma* is slightly thick-walled, and is chiefly of vasicentric or metatracheal arranged in short, continuous or intermittent, tangential bands, but less number of diffuse parenchyma also occurs (*p* in Fig. 4). Vertically, about a dozen or more parenchyma cells are

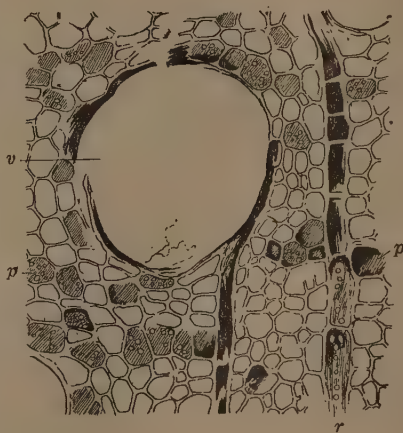


Fig. 4. *Quercinium anataiense* sp. nov. Transverse section of a small part of wood. *v*, vessel; *p*, wood parenchyma; *r*, medullary ray. ( $\times 220$ ).



arranged in a series, those on the both ends being pointed. They measure mostly  $12\text{--}40\ \mu$  in diameter and  $30\text{--}75\ \mu$  in length ( $p$  in Fig. 5 D). Frequently several cells on the median part of such a series become shorter, frequently each containing a simple crystal. Several round, simple pits on the horizontal walls are frequently found in transverse section.

There are *medullary rays* of two kinds, that is, the uniseriate and the broad compound (Photo. 2 D-F). Uniseriate rays, which are very

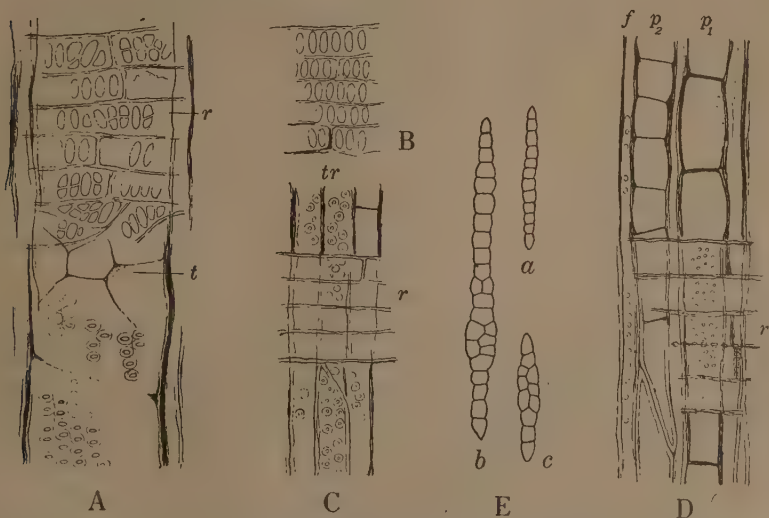


Fig. 5. *Quercinium anataiense* sp. nov. A, radial view of a vessel with tyloses ( $t$ ) and a ray, showing particular pittings between them. B, another example of pittings. C, radial view of a few tracheids. D, radial view of wood parenchyma ( $p_1$ ,  $p_2$ ) and wood fibre ( $f$ ). E, three examples of narrow rays in tangential section. (A-D,  $\times 220$ ; E,  $\times 80$ ).

rarely biseriate in part; 2-21 or more, mostly 3-11 cells or  $50\text{--}600\ \mu$  in height; individual cells are roundish square in shape in tangential section and  $20\text{--}40\ \mu$  in diameter (Fig. 5 Ea-c; Photo. 2 F). Usually 28-32 rays are present in 1 square mm. and ray intervals vary  $70\text{--}250\ \mu$ . Rows of rays are wavy in transverse section owing to the abundant presence of large vessels. In radial section rays are apparently homogeneous; individual cells are squarish in shape and measure  $20\text{--}40\ \mu$  in diameter; pittings into the vessels are mostly a horizontal rows of closely arranged, vertically elongated elliptical pores (Fig. 5 B; Photo. 2 G), but frequently such a pore is traversed by a horizontal bar to show a shape of figure  $\theta$

or takes round or other somewhat irregular shapes (Fig. 5 A); the pits into the tracheids are half-bordered, two to six in number (Fig. 5 C), and those into wood parenchyma are small, simple and five to ten or more in number (Fig. 5 D); horizontal and tangential walls are also pitted (*r* in Fig. 5 D). Broad compound rays are also abundant (Photo. 2 D-F). In tangential section they are long fusiform and measure 0.2–0.75 mm. in breadth and 2.5–10 mm. in height; they consist of great many number of roundish cells of smaller and larger size, the former measuring 8–20  $\mu$ , and the latter, 25–35  $\mu$  in diameter, the latter ones frequently containing simple crystals. In a ray of 0.5 mm. wide and 4.5 mm. high the number of cell reach 30 and 263 respectively. The intervals of broad rays vary 0.5–2.8 mm.

### Affinity

The present fossils are apparently a dicotyledonous wood and show many characteristic features, such as, the ring porosity with one or two rows of very large vessels, the absence of compound vessels, the presence of crowded, alternately arranged, elliptical bordered pits on the vessel walls, the simple perforation of the end-walls of vessel segments, the abundant presence of thyloses, the dominancy of the metatracheal and vasicentric parenchyma, the presence of the uniseriate and the large, fusiform compound rays, and vertically elongated palisade-like pittings between ray parenchyma and vessels. Judging from these characteristics, there are no doubts that these woods are similar to that of *Lepidobalanus*-type of living *Quercus* (RECORD 1919, KANEHIRA 1926, YAMABAYASHI 1938). However, the combination of other details of the structure such as the abundancy of thyloses, the arrangement of vessels in the late wood, the fact that the vessels in the late wood are tangentially flattened, the frequent occurrence of figures suggesting the crystals in the ray parenchyma as well as in the wood parenchyma, and the size of individual elements and the width and the height of uniseriate and compound rays, seems to show no accurate coincidence with any living species of subgn. *Lepidobalanus*, though they fairly resemble to a number of species, especially with *Quercus accutissima* CARR. (KANEHIRA 1926, YAMABAYASHI 1938).

The fossil woods related to *Quercus* have been found mostly since the Tertiary under the name *Kloedenia* GOEPPERT (1839), *Quercinium* UNGER (1842), *Quercites* GOEPPERT (1845), *Quercoxylon* HOFMANN (1926), *Schimperites* SCHLEIDEN (1855) or *Schmidites* SCHLEIDEN (1855). Nowadays, however, *Quercinium* UNGER is generally accepted, and under this name are listed more than thirty species from North America and Europe (EDWARDS 1931). Recently BOESHORE and JUMP (1938) des-

cribes a new species *Quercinium album* from the Tertiary of Idaho, North America, and the important characteristics of most species of *Quercinium* are compared in a table. These species, however, all differ from the fossils in hand. In our country, occurrence of a few species of *Quercinium* are also reported. *Quercinium hobashiraishi* OGURA (1932) from the Tertiary (Palaeogene) of Najima near Fukuoka City is apparently differs from present materials in some respects, especially in the arrangement of vessels. SHIMAKURA (1934) reported two species of *Quercinium*; one from the Tertiary of Miyagi Prefecture, showing close resemblance with the living *Q. accutissima* or *Q. variabilis*, and the other from the Tertiary of Tokyo Prefecture, showing similarities to the living *Q. cuscula* or *Q. serrata*. The rigid comparison with my fossils, however, is impossible owing to briefness of his description.

As no described species agree with the present specimens, they are believed to be a new species of *Quercinium*. Here the writer proposes the name *Quercinium anataiense* with the following diagnosis.

### Diagnosis

#### *Quercinium anataiense* sp. nov.

Dicotyledonous wood related to subgn. *Lepidobalanus* of *Quercus*. Boundaries of growth rings distinct; breadth of rings 1.0–2.5 mm. Vessels in early wood mostly round or slightly elongated in radial direction; one or two layered; mostly 250–320  $\mu$  in diameter. Those in late wood radial, oblique or flame-like in arrangement; comparatively small in size and round or slightly elongated in tangential direction in outline; mostly 80–140  $\mu$  in diameter, and nine to eleven per unit square. Vessel segments 90–410  $\mu$  in length; end walls with simple perforation and placed horizontally or nearly so; pits on lateral walls bordered, horizontally elliptical, 7–10  $\mu$  in diameter, with horizontal, flattened elliptical, pit-openings. Thyloses abundant. Tracheids abundant, 15–30  $\mu$  in diameter, with one or two rows of alternate, small, round bordered pits with round or elliptical pit-openings. Wood fibres also abundant. Wood parenchyma chiefly vasicentric and metatracheal; mostly 12–40  $\mu \times$  30–75  $\mu$  with pitted horizontal walls; crystals present. Medullary rays uniseriate and compound. Uniseriate rays, rarely biseriate in part, 2–21 or more cells or 50–600  $\mu$  high; ray intervals 70–250  $\mu$ ; 28–32 rays in 1 square mm.; pits into vessels, a row of vertical ellipse or, sometimes, in other slightly modified shapes. Broad rays compound, numerous, 0.5–2.8 mm. in intervals, upto 0.75 and 10 mm. in width and height respectively: simple crystal seems to be present in ray parenchyma.

From Anatai Village, Ninohe District; the lower half of the Miocene; collected by S. WATARI in 1940; Nos. 31129, 31130, 31133, 31142.



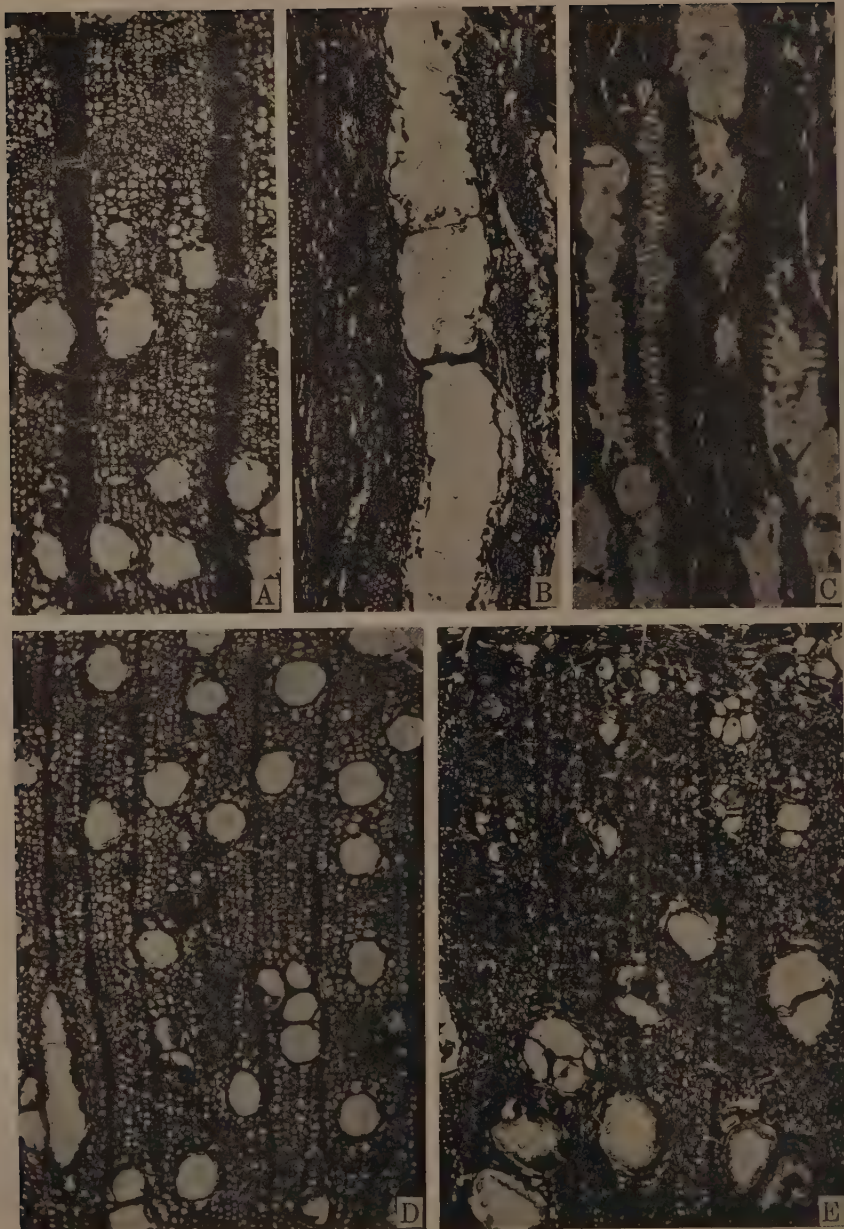


Photo. 3

*Ulmium zelkowiforme* sp. nov.

(Fig. 6; Photo. 3 A-C)

**Material.** No. 31140; a small decorticated wood about 8 cm. in diameter and 10 cm. in length; collected at Samuraimura, Anatai Village; preservation is generally poor, thus in most parts no details can be observed, while in some parts details of structure are rather excellently preserved.

## Description

Boundaries of *growth rings* are usually distinguished by the arrangement of large vessels and the presence of one or two layers of slightly flattened elements on the margin of each ring; breadth of the rings vary 0.3–1.2 mm. *Vessels* in the early wood are large, and are arranged in continuous, one or sometimes two tangential rows (Photo. 3 A). They are round in outline, rather thin-walled, and 50–200  $\mu$ , mostly 100–150  $\mu$  in diameter; between rays are found one or two, rarely three vessels (*V* in Fig. 6 A; Photo. 3 A); vessels segments short, measuring 70–200  $\mu$  in length; end walls place nearly horizontally and perforations are apparently simple; pits on the lateral walls are alternate, oval or round, bordered, 7–10  $\mu$  in diameter, with flattened elliptical or lenticular pit-openings; without spiral thickenings (Photo. 3 B). Vessels in the late wood are grouped in broad or narrow tangential, wing-like or festoon-like zones; individual pores are often polygonal in outline by mutual contact and 15–50  $\mu$  in diameter (*v* in Fig. 6 A); vessel segments measure 80–500  $\mu$  in length; end walls place nearly horizontally or slightly obliquely and are provided with simple perforations; pits on the lateral walls are bordered, alternate in arrangement, round or oval rarely polygonal in outline by mutual contact, and 5–8  $\mu$  in diameter; pit-openings are round or oval; there are marked spiral thickenings (Fig. 6 B; Photo. 3 C). There are no thyloses.

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Photo. 3. *Ulmium zelkowiforme* sp. nov. (A–C). A, transverse section of a part of wood through two growth rings. ( $\times 80$ ). B, tangential section; there are a large vessel consisting of short vessel segments with nearly horizontal end walls (middle) and several fusiform multiseriate rays. ( $\times 80$ ). C, radial section through a group of small vessels, showing their simple perforations and spiral thickenings on the wall. ( $\times 400$ ).

*Laurinium machiliforme* sp. nov. (D). D, transverse section of a small part of wood, showing rather narrow rays and somewhat angular vessels in diagonal arrangement. ( $\times 80$ ).

*Dicotyledonous wood* (E). E, transverse section of nearly the whole increment of a growth ring; there are solitary, large vessels with thyloses in the early wood, groups of small vessels in the late wood, and narrow rays.

Wood fibres are abundant, filling the areas between the groups of small vessels of the late wood and relatively irregular in arrangement; individual pores are round or polygonal in outline, thick-walled,  $10\text{--}20\ \mu$  in diameter, and  $2.5\text{--}5\ \mu$  in membrane thickness (Fig. 6 A); they are,

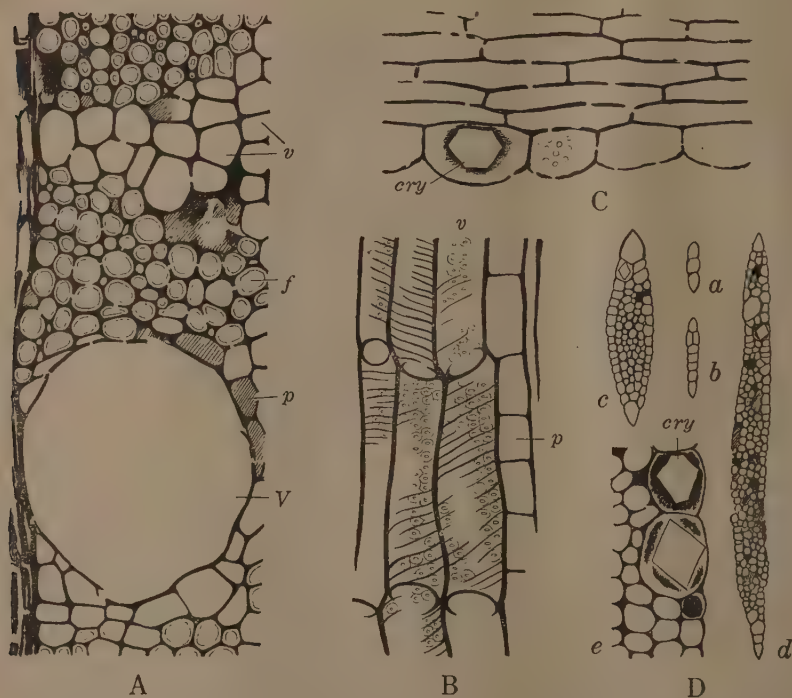


Fig. 6. *Ulminium zelkowiiforme* sp. nov. A, transverse section of a small part of wood. B, radial section of groups of small vessels with simple perforations and marked spiral thickenings. C, radial view of a part of a ray, a marginal cell bearing a crystal. D, tangential view of medullary rays; a, uniseriate ray; b, partly biseriate ray; c, d, multiseriate rays; e, peripheral part of a multiseriate ray, showing two, large, crystal-bearing cells. V, large vessel; v, small vessel; f, wood fibre; p, wood parenchyma; cry, crystal. (A–C, D<sub>e</sub>,  $\times 220$ ; D<sub>a–d</sub>,  $\times 80$ ).

however, neither preserved enough to measure their length not to determine the nature of pittings on the wall.

Wood parenchyma is slightly thick-walled, and chiefly of vasicentric and terminal, while a small quantity of diffuse one seems to be also present (p in Fig. 6 A). In transverse section the distinction from the



smaller vessel is rather difficult, but in longitudinal section they are easily distinguished by the horizontal walls (*p* in Fig. 6 B). Individual elements measure 25–40  $\mu$  in diameter and 40–200  $\mu$  in length. Pits are obscure.

*Medullary rays* distribute at fairly regular intervals (Photo. 3 A), there being two to six rays in breadth of 1 mm. They are mostly multiseriate, fusiform and heterogeneous but frequently almost homogeneous; they are 2–8, mostly 3–6 cells or 15–100  $\mu$  in breadth and 5–50, mostly 15–35 cells or 70–700  $\mu$  in height; the marginal one or two, rarely more rows of cells are large; in tangential section marginal elements are oval or broad oval in shape and in radial section they are nearly equal in length and height or slightly elongated to the radial direction, measuring 50–100  $\mu$  in breadth, 70–130  $\mu$  in height and 70–200  $\mu$  in length (Fig. 6 Dc, d; Photo. 3 B). These elements frequently contain large simple crystals (Fig. 6 C). Median cells are procumbent and long cylindrical, 20–40  $\mu$  in diameter and 80–250  $\mu$  in length (Fig. 6 C); often large crystal-bearing elements are present on the peripheral parts (Fig. 6 De). Narrow rays occur though they are relatively small in number, they being uniseriate or partly biseriate and 2–10 cells in height. They consist of shorter and broader elements compared with median procumbent cells of the multiseriate rays. On the wall between ray parenchyma and vessel, are found several, alternately arranged round pits, but it is not determined whether they are simple or bordered.

### Affinity

There are many characteristic features in the present dicotyledonous wood, that is, the ring porosity with large vessels, the wing-like or festoon-like tangential groups of the small vessels in the late wood, the simple perforation of the vessel, the intensive development of the masses of wood fibres filling the groups of small vessels. These features suggest at first that the present fossil relates, among the living plants, to some members of the Ulmaceae (*Ulmus*, *Hemiptelea*, *Zelkova*), Rutaceae (*Phelodendron*) or Araliaceae (*Aralia*, *Kalopanax*). However, in comparing the further details of structures, such as the presence of one or two rows of large vessels in the early wood, the shortness of the vessel segments, the presence of the well-marked spiral thickenings on the walls of vessels of the late wood, the absence of the thyloses, the dominancy of the heterogeneous structure of the rays, the presence of large, simple crystals in the ray parenchyma, the breadth of rays, the intensive development of thick-walled wood fibres, etc., it is easily recognized that this fossil most resembles the wood of *Zelkova*—*Z. serrata* MAKINO (KANEHIRA 1926, YAMABAYASHI 1938). Though several fossil woods related

to *Ulmus* have been reported under the name *Ulmium* UNGER (1842, cf. EDWARDS 1931), the wood related to *Zelkova* have never been described from the Tertiary within the extent that the writer is aware<sup>(1)</sup>. The general structures, however, are nearly the same in both *Ulmus* and *Zelkova* excepting a slight difference in the structure of rays. Here, it is generally accepted that in *Ulmus*, rays are usually homogeneous and sometimes show a tendency of the heterogeneous structure, while in *Zelkova* they are usually heterogeneous, but often incline to be homogeneous. So that it seems better, in describing the fossil wood of *Zelkova*, to use the form-genus *Ulmium*, than describe it under a new name. Thus I here propose a new species *Ulmium zelkowiforme*, the specific name given owing to the resemblance with the living *Zelkova serrata*.

### Diagnosis

#### *Ulmium zelkowiforme* sp. nov.

Dicotyledonous wood related to *Zelkova*. Boundaries of growth rings distinct only by ring porosity and a few layers of slightly flattened, terminal elements. Ring-porous with one to two layers of vessels; pores large, round mostly 100–150  $\mu$  in diameter; length of vessel segments 70–200  $\mu$ ; pits on lateral walls bordered, alternate, oval or round, 7–10  $\mu$  in diameter, with horizontal, elliptical or lenticular pit-openings; end walls with simple perforations, horizontal or slightly oblique; no spiral thickenings; without thyloses. Vessels in late wood grouped in tangential, wing-like or festoon-like zones; pores 15–50  $\mu$  in diameter; vessel segments 80–500  $\mu$  in length, with horizontal or more or less oblique, simply perforated end walls; pits on lateral walls bordered, round or oval or rarely polygonal in outline, arranged alternately, and provided with round or oval pit-openings; distinct spiral thickenings present. Wood fibres with thickened walls abundant; zonate and filling vessel groups in late wood. Wood parenchyma chiefly vasicentric and terminal. Medullary rays uniseriate and multiseriate; two to six rays in breadth of 1 mm.; 1–8, mostly 3–6 cells wide, and 2–50, mostly 15–30 cells high; heterogeneous or sometimes almost homogeneous, consisting of shorter and broader marginal cells, frequently each containing simple crystal, and long, cylindrical, procumbent, median cells.

From Samuraimura, Anatai Village, Ninohe District, Iwate Prefecture; the lower half of the Miocene; collected by S. WATARI in 1940; No. 31140.

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(1) The wood of *Zelkova serrata* is reported by SHIMAKURA (1936) from the submerged forest at Uodzu, Toyama Prefecture (Quaternary).

*Laurinium machiliforme* sp. nov.

(Fig. 7, Photo. 3 D)

**Material.** No. 31144; a decorticated wood, about 25 cm. in diameter; collected at Samuraimura, Anatai Village; preservation is generally poor, but in some parts considerable details are observable.

## Description

Boundaries of *growth rings* are faintly distinct; their breadth is fairly uniform, varying 2.2–4.5 mm., mostly 3.0–4.0 mm. *Vessels* are small in number and are scattered evenly throughout the wood; disposing singly or two to three connected in radial, rarely in diagonal or tangential series, or three or more are clustered. Generally, these solitary or

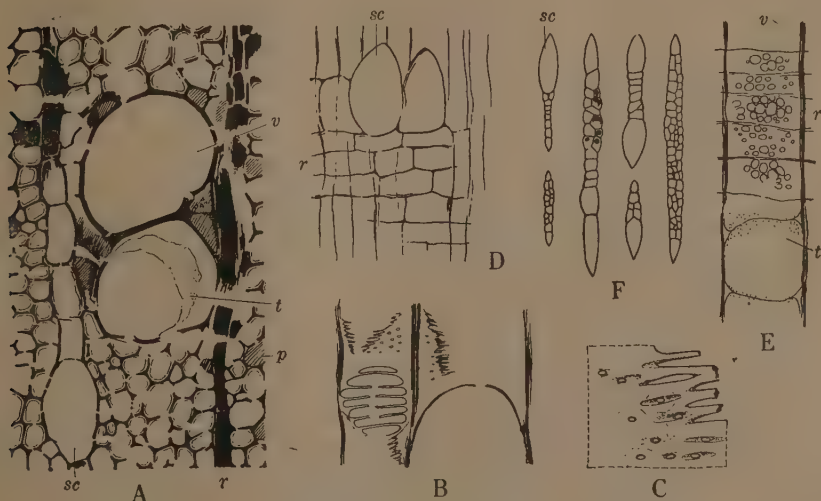


Fig. 7. *Laurinium machiliforme* sp. nov. A, transverse section of a small part of wood. B, radial view of two vessels, one with simple, and another with scalariform perforations. C, details of pitting on the vessel wall. D, radial section showing marginal part of a heterogeneous ray, there being two large elements (secretory cells). E, showing a vessel with thyloses and ray-vessel pitting. F, several examples of medullary rays in tangential section. v, vessel; t, thyloses; p, wood parenchyma; sc, secretory cell (probably). (A, B, D, E,  $\times 220$ ; C,  $\times 550$ ; F,  $\times 80$ ).

grouped vessels show, as a whole, a prominent tendency of the diagonal arrangement (Photo. 3 D). Pores are almost round or somewhat angular in outline, and usually slightly diminish their size in the late wood, but sometimes nearly uniform throughout the increment; their diameter



measures mostly 70–100  $\mu$ , the largest in the early wood and the smallest in the late wood being 135  $\mu$  and 25  $\mu$  respectively (Fig. 7 A; Photo. 3 D); in 1 square mm. they number 18–44, mostly 24–35, averaging 28. End walls of vessel segments are usually more or less oblique and are provided with mostly simple, sometimes scalariform perforations, in the latter case the intervals of cross bars varying 4–15  $\mu$  or slightly more, mostly 6–10  $\mu$  (Fig. 7 B). The lateral walls of vessels are usually solid black in colour, only showing the presence of alternately or oppositely arranged, horizontally elongated oval or sometimes nearly round, small pores which are 1.5–3  $\mu$  in diameter (Fig. 7 B). But in some parts it is clear that these pores are openings of the closely arranged, round, bordered pits measuring 5–8  $\mu$  in diameter. A very interesting fact must be here noted. When a part of wall is rubbed away in the course of making preparations, there are frequently found, on the free margin of the wall, more or less regularly arranged, parallel and thread-like parts (Fig. 7 B). At first it was understood that they are parts of the spiral thickenings along the inner surface of vessel wall, but a close observation revealed that this owes to a special structure of the pit-openings. That is, the oval or round pore is only the opening at the summit of the room of a bordered pit and it is, soon, widened and horizontally stretched, thus such an opening gathering together to show a more or less regular scalariform or net-like patterns on the inner surface of vessel and the thread-like parts on the free margin of the wall correspond, in fact, to the parts insetting between these narrow openings (Fig. 7 C). Often two or more pores come to a single, long and narrow opening; they are usually 2.5–4  $\mu$  in breadth and 10–20  $\mu$  or more in length. Thin-walled thyloses occur in many vessels (t in Fig. 7 A, E).

Elements filling the areas between vessels are fairly uniform in size, roughly hexagonal in outline and are arranged in more or less regular radial rows; they appear to be thick-walled and measure mostly 15–30  $\mu$  in diameter (Fig. 7 A); their walls are thin in the early wood and fairly thickened in the late wood (2–5  $\mu$ ); longitudinally they show sharp pointed ends. That these elements are *wood fibres* is thus evident, though accurate length or nature of pittings has not been able to determine.

*Wood parenchyma* is chiefly vasicentric and a small quantity of diffuse parenchyma seems to be also present (Fig. 7 A); further details are not clear.

*Medullary rays* are all narrow and are uniformly distributed, there being five to eight rays in breadth of 1 mm. In radial section they are apparently heterogeneous and consist of relatively thin-walled elements; the marginal cells are upright, mostly 15–30  $\mu$  long and 35–60  $\mu$ , sometimes up to 100  $\mu$  high, the height often corresponding four or five times of the length; between marginal cells are intermixed, here and there,

especially large, broad oval elements, reaching up to  $40\ \mu$  long and  $50\text{--}80\ \mu$ , often more than  $100\ \mu$  high (see in Fig. 7 A, D, F); median cells mostly procumbent, squarish,  $25\text{--}70\ \mu$  long and  $10\text{--}20\ \mu$  high (Fig. 7 D), but often mix a few, mostly one or two layers of upright cells; pits into vessels are round or elliptical,  $1.5\text{--}10\ \mu$ , mostly  $3\text{--}8\ \mu$  in diameter, and are usually opposite or alternate in arrangement, but occasionally somewhat irregular net-work (Fig. 7 E). In tangential section the marginal cells are narrow or broad oval in shape,  $15\text{--}30\ \mu$  in breadth, the intermixed large elements reaching  $100\ \mu$  broad; the median cells are uniseriate to triseriate. The uniseriate part consists mostly of round-squarish elements, mostly  $10\text{--}25\ \mu$  in diameter, occasionally mixing a few vertically elongated elements; in bi- or triseriate part, elements are somewhat irregular and polygonal in shape and are mostly  $5\text{--}15\ \mu$  in diameter; median part of rays measures  $10\text{--}45\ \mu$ , mostly  $15\text{--}35\ \mu$  in breadth and  $75\text{--}550\ \mu$ , mostly  $100\text{--}400\ \mu$  in height (Fig. 7 F).

The large elements are not always associated to the marginal part of the rays, but some are scattered independently among the fibrous elements.

### Affinity

The faintly distinct growth rings, the diffuse porosity with a relatively small number of vessels, with or without slight diminution of vessel size at the periphery of a growth ring, and with a tendency of diagonal arrangement; opposite or alternate bordered pits on the lateral walls of vessels; relatively large, round or elliptical pits between vessel and ray; admixture of simple and scalariform perforations on the end walls; these features suggest first of all that this fossil is no other wood than that of a lauraceous plant (RECORD 1919, KANEHIRA 1926, YAMABAYASHI 1938). This consideration becomes much more reasonable when one recalls the structure of rays, the large cells among the fibrous elements, and the particular structure of the pit-openings on the vessel walls.

The medullary rays in lauraceous plants are almost always heterogeneous and are characterized by the presence of especially large elements—*secretory cells*—in the marginal upright cells. The secretory cells are also scattered among the fibrous elements. The large elements in the present fossil apparently show an identity with these secretory cells in their localization as well as in their size and form. The particular pit-openings on the vessel wall are so common in the lauraceous plants such as *Benzoin*, *Cinnamomum*, *Machilus*, etc. In comparing further details, such as the size of vessels, the number of vessels in a group, the size of pits on the vessel wall, the size of ray-vessel pitting, etc., with

those of many living species of the family, it comes nearest to the wood of *Machilus Thunbergii* SIEB. et ZUCC.

Since UNGER (1845) proposed the generic name *Laurinium* to a fossil wood related the lauraceous plants, about thirty species have been reported by many authors from the Cretaceous and the Tertiary of various parts of the world. These fossils were described under several generic names, such as *Laurus*, *Laurinium*, *Lauroxylon*, *Laurinoxylon*, *Perseoxylon*, *Ocotoxylon*, *Cinnamomum* or *Tetranthera*, and were compared with living species of *Laurus*, *Cinnamomum*, *Ocotea*, *Persea*, *Oreodaphne*, *Nectandra*, *Dicypellium*, *Mithridata* or *Tetranthera*. EDWARDS (1931), however, used *Laurinium* for all of these species after comparing the diverse opinions of the previous authors.

As the comparison of present fossil with any of these species is virtually impossible, it seems better to describe it under a new name, *Laurinium machiliforme*. The generic name follows the opinion of EDWARDS and the specific name *machiliforme* is derived from the resemblance between the present fossil and the wood of *Machilus Thunbergii*.

## Diagnosis

### *Laurinium machiliforme* sp. nov.

Dicotyledonous wood related to lauraceous plants especially to *Machilus*. Boundaries of growth rings faintly distinct. Vessels diffuse, mostly single or two to three connected radially, or occasionally connected diagonally or tangentially, sometimes three or more grouped in cluster, vessels as a whole arranged diagonally; pores almost round or somewhat angular in outline; mostly 70–100  $\mu$ , up to 135  $\mu$  in diameter; 18–44, mostly 24–35, 28 in average, in 1 square mm.; end walls of vessel segments apparently oblique with mostly simple, sometimes scalariform perforations, in the latter case intervals of cross bar, 4–15  $\mu$  or more, mostly 6–10  $\mu$ ; pits on vessel walls bordered, opposite or alternate in arrangement, with horizontally oval, sometimes round, opening at summit of room of bordered pit which is rapidly transformed into horizontally stretched, long, lenticular opening toward inner surface of vessel wall. Thin-walled thyloses present in many vessels. Wood fibres abundant, libriform, arranged in more or less regular radial rows; mostly 15–30  $\mu$  in diameter and 2–5  $\mu$  in membrane thickness. Wood parenchyma mostly vasicentric, sometimes diffuse (?). Medullary rays heterogeneous, 1–3 cells or 10–45  $\mu$ , mostly 15–35  $\mu$  in breadth at median part, and 75–550  $\mu$ , mostly 100–400  $\mu$  in height; consist of marginal upright cells intermixed with especially large, oval elements (secretory cells ?), and median procumbent and upright cells; cell walls relatively thin; pits into vessels



round or elliptical, mostly  $3-8\ \mu$  in diameter, opposite, alternate or sometimes in network in arrangement. Large elements (secretory cells ?) also scattered among fibrous elements.

From Anatai Village, Ninohe District; the lower half of the Miocene; collected by S. WATARI in 1940; No. 31144.

### *Dicotyledonous wood*

(Photo. 3 E)

**Material.** No. 31141; a longitudinal half of decorticated stem about 6.5 cm. in diameter and 10 cm. in length; collected at Samuraimura; preservation is generally poor.

### Description

Boundaries of *growth rings* are present but indistinct being known only by the arrangement of vessels; breadth, 0.8–2.6 mm., mostly 1–2 mm. In the early wood *vessels* formed at the beginning of the ring are especially large, gradually diminishing their size towards the late wood (Photo. 3 E). They are usually scattered singly, but sometimes two, rarely three are connected radially or diagonally, single pore is round or radially oval in outline, measuring radially  $100-350\ \mu$ , mostly  $140-225\ \mu$  and tangentially  $80-230\ \mu$ , mostly  $125-200\ \mu$  in diameter; 8–21, mostly 11–17 vessels occur in 1 square mm. In the late wood the vessels are grouped in cluster; individual vessels measure  $15-100\ \mu$ , mostly  $25-70\ \mu$  in diameter and there are 17–23 vessel groups in 1 square mm. The vessel segments vary  $90-250\ \mu$ , mostly  $130-180\ \mu$  in length; end walls place almost horizontally in large vessels and obliquely in smaller ones; perforations are apparently simple; pits on lateral walls are circular to oval in outline, opposite or alternate in arrangement, and are provided with round or horizontally oval pit-openings; fine, closely coiled, spiral thickenings are present in the small vessels of the later wood. Thin-walled thyloses occur almost in every vessels.

Elements other than vessels are polygonal in section, rather irregular in arrangement, and mostly measure  $7-15\ \mu$  in diameter. Though they seem to be *wood fibres*, the distinctions between wood fibres and parenchyma or tracheids are actually impossible owing to their bad preservation.

In tangential section all *medullary rays* seem to be narrow, though their figures observed are rather few in number; they are mostly uniseriate or occasionally biseriate; 5–10 rays occur between breadth of 1 mm. Individual cells are round, isodiametric and  $15-50\ \mu$ , mostly  $20-40\ \mu$ , in diameter; 2–11, mostly 3–7 cells or  $50-400\ \mu$ , mostly  $80-200\ \mu$  high. In radial section rays apparently homogeneous, consisting of short

procumbent cells, 30–50  $\mu$  in length by 25–40  $\mu$  in height. Crystals seem to be present in ray cells.

### Affinity

From the foregoing description, the present specimen is apparently a dicotyledonous wood. The ring porosity with very large vessels, the grouped disposition of the vessels in the late wood, the presence of the spiral thickenings on the vessel walls of the late wood, the simple perforation of the end wall of vessels, and the narrow rays, seem to be characteristics in the identification of the present fossil. From these features, it is probably a wood belonging to the Anacardiaceae (*Rhus*, etc.) or Leguminosae (*Cladrastis*, etc.) (RECORD 1919, KANEHIRA 1926, HEIMISCH 1940). The further determination, however, is actually impossible owing to the bad preservation of the material.

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# Studies on the fossil woods from the Tertiary of Japan

## II. Fossil woods from the River Nesori, Namiuti Village, and the River Hiranuka, Kozuya Village, Ninohe District, Iwate Prefecture<sup>(1)</sup>

By Shunji WATARI

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With 5 figures and 3 photographs in the text

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In the first contribution, it is reported that there is exposure of numerous fossil woods along the river Mabetsi and its branches, the rivers Nesori and Hiranuka, and are described several species, a coniferous and five dicotyledonous woods from the first named river. The present paper deals with the results of the investigation on materials collected at the latter two rivers.

Along the river Nesori which passes through the Namiuti Village, fossil woods are especially abundant at three different places. In the first place, fossils are exposed in the cliff of a village road along the river at a vicinity of Nesori, and in the second and third in the sides or bed of the river, mostly lying, some erecting on the basal rock. Weathering surfaces of them are usually iron-stained or grayish in colour. They are petrified in a close, hard, silicified medium and in most materials preservation of the internal structure is excellent. Studying about twenty-five examples obtained there, are found the following four species containing two coniferous and two dicotyledonous woods:—

<i>Piceoxylon Wakimizui</i> sp. nov.	2 examples
<i>Taxodioxylon sequoianum</i> (MERCKL.) em. GOTHAN.	12 "
<i>Fegonium hondoense</i> sp. nov.	6 "
<i>Acerinium iwataense</i> , sp. nov.	2 "

A considerable number of erect stumps is exposed on the bed rock of another branch, the river Hiranuka, at Nakamura, Kozuya Village. All of them are iron-stained or grayish in weathering surfaces, preservation of the internal structure being excellent. About ten materials were

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(1) Contributions from the Divisions of Plant-Morphology and Genetics, Botanical Institute, Faculty of Science, Tokyo Imperial University, No. 277.

obtained there, but all of them belong to one and the same species:—*Taxodioxylon sequoianum*.

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### *Piceoxylon Wakimizui* sp. nov.

(Figs. 1, 2; Photo. 1)

**Materials.** No. 31102; a silicified wood with bark exposed in the cliff along the road; elliptical in transverse section, 15 cm. and 12 cm. in diameters; collected at Nesori, Namiuti Village; preservation is rather good, though the spring wood is fairly deformed and walls of some elements show swelling. No. 31118; a part of large, silicified and carbonized, rather poorly preserved wood about 50 cm. in diameter; collected at the bed of the middle stream of the river Nesori, Namiuti Village.

### Description

*Growth rings* are well marked, rather narrow, measuring 0.5–2.0 mm. usually 1–1.5 mm. in breadth. Transition from the early to the late wood is gradual or somewhat abrupt (Photo. 1 A). *Tracheids* of the early

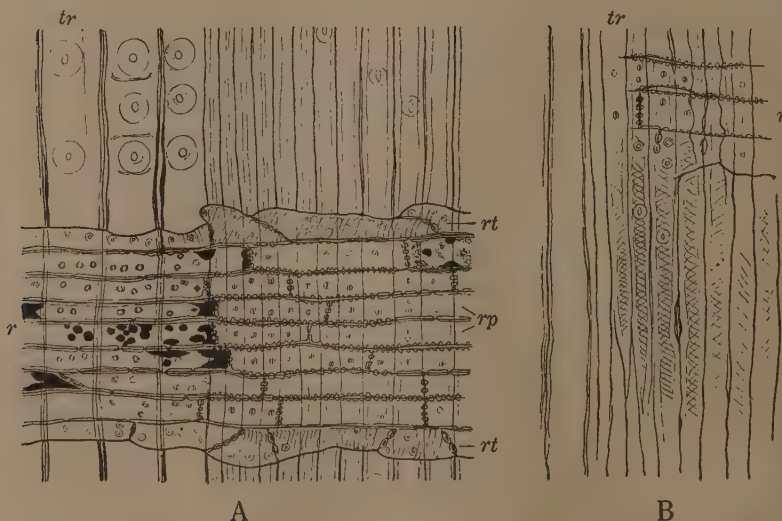


Fig. 1. *Piceoxylon Wakimizui* sp. nov. A, radial section through a boundary of growth rings showing details of the structure of a medullary ray. B, radial section of a small part of the late wood, showing spiral thickenings in tracheids. tr, tracheid; r, medullary ray; rt, ray tracheid; rp, ray parenchyma. ( $\times 220$ ).

wood are fairly small, thin-walled, radially elongated squarish or polygonal with rounded corner in outline; intercellular spaces are sometimes distinct; bordered pits on the radial walls are large, circular or



oval,  $2/3$ – $3/4$  of the tracheid width in diameter, with round or oval pit-openings, separated from or sometimes contact with one another, and are arranged usually in one or rarely two rows; when in two rows they are mostly opposite, occasionally alternate in arrangement, such an arrangement occurring rather frequently in ends of the tracheids; bars of SANIO are frequently distinct (Fig. 1 A, 2 A). Tracheids of the late wood are usually squarish, sometimes polygonal with rounded corner, tangen-

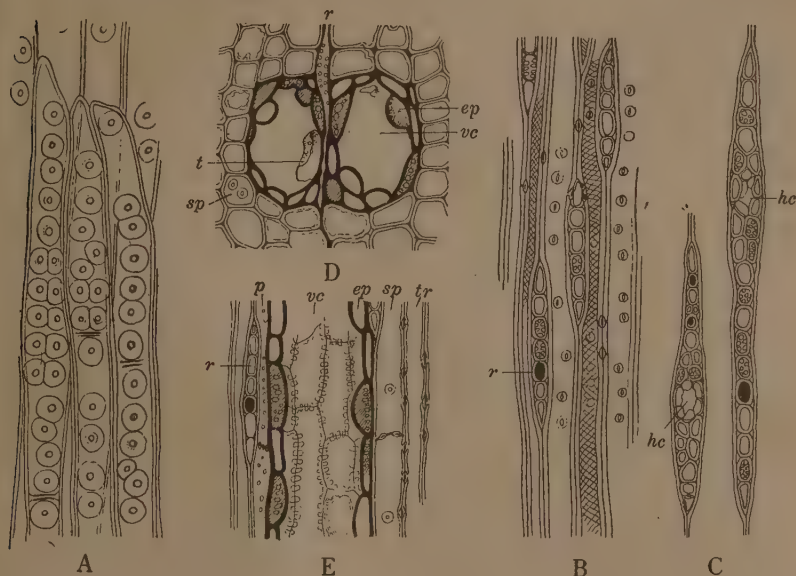


Fig. 2. *Piceoxylon Wakimizui* sp. nov. A, radial view of tracheids showing the arrangement of bordered pits. B, tangential section of a small part of the late wood showing details of medullary rays, bordered pits on the tangential walls and spiral thickenings in some tracheids. C, two examples of fusiform rays. D, transverse section showing details of two vertical resin canals separated by a medullary ray. E, tangential section containing a vertical resin canal. *tr*, tracheid; *r*, medullary ray; *vc*, vertical resin canal; *ep*, epithelial cell; *p*, wood parenchyma; *sp*, septate tracheid. ( $\times 220$ ).

tially flattened and very thick-walled; bordered pits on the radial walls are rather small and circular with vertical and lenticular pit-openings; they are separated from one another and arranged in one row (Fig. 1 A, B); bordered pits on the tangential walls are circular in outline, arranged widely separated one another in one or somewhat alternate rows, their pit-openings being small, lenticular and vertical or slightly oblique (Fig. 2 B; Photo. 1 C). Along the inner surface of the late wood

tracheids, usually in those of smaller size, fine spiral thickenings are occasionally present (Fig. 1 B, 2 B; Photo. 1 C).

Terminal and diffuse *wood parenchyma* seems to be entirely absent. *Vertical resin canals* are relatively numerous and conspicuous, and are distributed chiefly in the late wood or in the lately formed early wood in somewhat wavering tangential bands; they usually occur singly, but sometimes two or three are arranged in a tangential series (Photo. 1 A, B). Epithelial tissue lining a canal consists of very thick-walled and densely pitted elements which frequently project into the cavity of the canal (Fig. 2 D; Photo. 1 B); thin-walled thyloses occur in some canals. Surrounding the epithelium, there occurs a small quantity of wood parenchyma. Between the epithelial layer and the normal tracheids, there observe one or two layers of different elements. Their length is much similar to that of the epithelial cells or wood parenchyma, but they are characterized by small, round, bordered pits on the lateral and horizontal walls, their end walls placing horizontally or obliquely (*sp* in Fig. 2 D, E).

There are *medullary rays* of two kinds, that is, the uniseriate rays and the multiseriate ones containing a horizontal resin canal. Uniseriate rays occasionally become biseriate in part length of ray cells radially corresponds two to eight, usually five or six tracheids; rays are separated by one to nineteen, usually three to eight tracheids; 1-18, mostly 2-11 cells high; 55-80 or a little more rays in 1 square mm.; form of the ray cells in tangential section is round, oval or squarish with rounded corner, sometimes much elongated, the triangular intercellular spaces being usually very clear; their width varies for a considerable extent (Fig. 2 B, E; Photo. 1 C, D). Usually they consist of median parenchymatous cells and marginal ray tracheids. Median cells are fairly thickened and pitted; pits on the horizontal walls are especially numerous in the late wood, small, circular, simple, and are arranged mostly in two rows (Fig. 2 D); tangential wall place vertically or obliquely and are provided with one to nine, mostly four to seven, circular or oval, irregularly disposed simple pits (Fig. 2 B, C; Photo. 1 C, F); pits into the tracheids are apparently half-bordered, rather small, round or oval, arranged mostly in one, rarely two rows, pit-openings being oval or lenticular placed horizontally or obliquely in the early wood and vertically or nearly so in the late wood; in a cross field they number one to four, rarely five in the early wood and one or two in the late wood (Fig. 1 A; Photo. 1 E, F). Marginal tracheids are thin-walled, their margins being smooth and usually more or less curved; tangential walls are vertical, oblique or curved. There are one or two, rarely three, small, round bordered pits in a cross field, and a few bordered pits also occur on the tangential walls (Fig. 1 A; Photo. 1 E). Along the inner surface of the ray tracheids

of the late wood, occasionally also of the early wood, are found fine spiral thickenings (Fig. 1 A; Photo. 1 E). Mostly one or two, occasionally three or more rows of ray tracheids occur on each margin of a ray. There are however often the rays with no median cells, but they consist only of the ray tracheids. Such is the case when they are one or two cells high, rarely even in that of four or five cells high. Broad rays, each containing a horizontal resin canal, occur one or two in 1 square mm. They are slender fusiform in tangential section; horizontal resin canals are usually small or of medium size and are lined with a layer of two to seven, small, fairly thin-walled epithelial cells (Fig. 2 C; Photo. 1 D).

There are frequently found, at the beginning of the growth rings, tangential rows of groups of somewhat swollen, thick-walled, densely pitted elements with irregular forms. In such a region the ray tracheids show much irregular shapes and are often very elongated so as to take a form of normal tracheids, tracheids also showing some disarrangement and their ends being often irregularly curved or swollen.

In *bark*, which structure is usually ill-preserved, there is alternation of bands of the stone cells and the thin-walled elements; stone cells are very thick-walled, irregular-shaped and pitted by fine ramified or unramified canals (Photo. 1 G); thin-walled elements are mostly destroyed but the presence of the regularly arranged squarish elements and somewhat large elements containing crystals is suggested. Such crystal-bearing cells are rarely present amongst the groups of stone cells.

### Affinity

The following respects clearly indicate that this abietinean wood is a member of *Piceoxylon* GOTHAN (1905), that is, the presence of vertical and horizontal resin-canals, thickened and pitted epithelial cells of vertical canals, fine spiral thickenings of ray tracheids, etc. Among living genera of Abietineae, the woods of three i.e. *Picea*, *Larix* and *Pseudotsuga* may be included in *Piceoxylon* in fossilized condition. The other features, such as, the presence of spiral thickenings in some late wood tracheids, the occasional occurrence of the opposite or alternate arrangement of bordered pits on the radial walls of early wood tracheids, the absence of the wood parenchyma excepting in vicinity of canals, the more or less gradual transition from the early to the late wood, the tendency in which the epithelial cells project into the cavity of canals and the presence of large groups of stone cells in the bark, seem to be very important in the consideration of further affinity.

The occurrence of spiral thickenings on the walls of tracheids in these three genera have been repeatedly discussed by many authors, and they agree with in the respect that, in *Pseudotsuga*, spiral thickenings



are present throughout the whole wood or at least in the early wood. Regarding to *Picea* and *Larix*, however, the result of observations by authors is not always coincide; e.g. the spiral thickenings are wholly absent in *Picea* and present in the late wood of *Larix* (FUJIOKA 1913); they are occasionally present in the tracheids of the late wood of *L. leptolepis* GORD. (KANEHIRA 1926); they are absent in both genera (PENHALLOW 1907); they are sometimes present in both genera (GOTHAN 1905, RECORD 1919); they are present also in the early wood of certain *Picea* (BAILEY 1909, JONES 1924); etc. In the recent year, MIYOSHI and SHIMAKURA (1933) observed in some Japanese species of *PICEA* and *LARIX* that the spiral thickenings are present in the early wood tracheids of *P. Maximowiczii* REGEL, *P. morisonicola* HAYATA, *P. smithiana* BOISS. and in the late wood tracheids of *P. Koyamai* SHIRASAWA, the tendency of their formation in the last species being much more vigorous than in the case of *Larix*. Thus the present material should belong, in this respect, to *Larix* or a certain form of *Picea*.

The opposite pits on the radial walls are present in both genera, but they seem to occur quite usually in *Larix* and rather rarely in *Picea*. There is present a less number of wood parenchyma in the most species of *Larix*, such as *Larix Gmelinii* REHD. var. *coreana* (NAKAI) UEKI *L. leptolepis* GORD., *L. kurilensis* (GOTHAN 1905, PENHALLOW 1907, YAMABAYASHI 1938, KANEHIRA 1926), while it is absent in *L. Griffithi* HOOK. f. et THOMS. (KANEHIRA 1924a); it is absent in most species of *Picea*, e.g. *Picea hondoensis* MAYR., *P. bicolor* MAYR., *P. morisonicola* HAYATA., *P. yezoensis* CARR., *P. koraiensis* NAKAI (GOTHAN 1905, PENHALLOW 1907, KANEHIRA 1926, YAMABAYASHI 1938) and is present only in *P. Morinda* LINK. (KANEHIRA 1924b). The transition from the early to the late wood is usually abrupt in every species of *Larix* above mentioned, while is usually more or less gradual in all species of *Picea* (YAMABAYASHI

Photo. 1. *Piceoxylon Wakimizui* sp. nov. A, transverse section of the wood through three growth rings. ( $\times 20$ ). B, transverse section of a small part of wood, showing the gradual transition from the early to the late wood and three vertical resin canals. ( $\times 100$ ). C, tangential section of a small part of the late wood, showing the abietinean pittings on the tangential walls of ray parenchyma (left), two tangential bordered pits of a tracheid (middle) and a tracheid bearing spiral thickenings (right). ( $\times 500$ ). D, tangential section of a small part of the wood, containing two vertical resin canals, many uniseriate rays and a fusiform ray (upper left). ( $\times 100$ ). E, radial section of an uniseriate ray showing marginal ray tracheids with bordered pits on radial and tangential walls and spiral thickenings (faintly distinct in the figure). ( $\times 500$ ). F, the same showing pitted and thickened, horizontal and tangential walls of ray parenchyma. ( $\times 500$ ). G, transverse section of a small part of bark showing groups of stone cells in a tangential band. ( $\times 150$ ).



Photo. 1



Photo. 2



1938, KANEHIRA 1924b, 1926). That the epithelial cells project into the cavity of canals seems to be a characteristic feature of some *Picea*, such as *P. koraiensis* (YAMABAYASHI 1938), *P. hondoensis* (KANEHIRA 1926). From these respects, the features represented by the present materials are rather of those of *Picea*.

It was described that there are only the stone cell groups in the bark of *Abies*, *Cedrus*, *Picea* and *Tsuga*, and only solitary and scattered fibrous sclerotic cells in *Larix* and *Pseudotsuga* (SHIMAKURA 1936b), and that the groups of stone cells are arranged in tangential bands in *Picea* and *Abies* (TAKAMATSU 1928). From this point of view, the present fossil is again similar to the species of *Picea*.

Thus it is known that the present fossil is a form of *Picea*-wood among *Piceoxylon*.

A number of species of *Piceoxylon* GOTHAN, including a few from our country, have hitherto been reported, but some of them, e.g. *Piceoxylon antiquis* GOTHAN (1910), *P. piceoides* VATER (1884), *P. scleomedullosum* SHIMAKURA (1937), *Pityoxylon statenense* JEFFREY et CHRYSLER (1906, HOLLICK and JEFFREY 1909), *P. scituetense* JEFFREY et CHRYSLER (1906), all of which from the Cretaceous, apparently differ from the present specimen in the absence of ray tracheids. *Piceoxylon transiens* SHIMAKURA (1937) from the Upper Cretaceous of Hokkaido shows some resemblance in general features, but it clearly differs from the present specimen in the occasional occurrence of the spiral thickenings in some tracheids of the early as well as the late wood, alternate bordered pits of the tracheids, form of the fusiform rays, the presence of a small quantity of the terminal and diffuse parenchyma, etc. *Pityoxylon Benstedii* reported by STOPES (1915) from the Lower Greensand (Aptian) of Kent also shows some resemblance, but it differs from the specimen in hand in that the bordered pits on radial walls of tracheids are always arranged in a single row, the absence of spiral thickenings in the tracheids and the nature of ray, especially in the occasional presence of large simple pits in the ray parenchyma. SHIMAKURA (1936a, 1937a) reported about a dozen examples of *Piceoxylon* spp. from various younger horizon

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Photo. 2. *Fegonium hondoense* sp. nov. A, transverse section of a small part of wood through five growth rings. ( $\times 20$ ). B, one part of A magnified, showing the arrangement of vessels in the early and late wood, a broad ray and several narrow rays. ( $\times 100$ ). C, tangential section of the wood, showing uniseriate, multiseriate and broad compound rays. ( $\times 80$ ). D, radial section of the wood, showing the vessels with simple perforations and scalariform, elliptical or round bordered pits in opposite arrangement on their walls. ( $\times 200$ ). E, radial section showing the characteristic pitting between vessel and ray parenchyma. ( $\times 500$ ).

(Tertiary and Quaternary) of Kanto and Tohoku Districts, but he gave no descriptions.

Thus, so far as my present knowledge concerns, there are no described species agreeing with my specimen, and it is believed to be a new type of *Picea*-like wood. The specific name given is devoted to em. Prof. T. WAKIMIZU under whose suggestion and kindness many material were obtained.

### Diagnosis

#### *Piceoxylon Wakimizui* sp. nov.

Abietinean wood with both horizontal and vertical resin canals. Boundaries of growth rings distinct; transition from early to late wood somewhat abrupt. Tracheids of early wood rather small, thin-walled, regularly arranged, without spiral thickenings; radial bordered pits large, circular or oval with rather small, circular or oval pit-openings, separated or sometimes contact, arranged in one or two rows, mostly opposite when in two rows, bars of SANIO often present. Tracheids of late wood thick-walled occasionally with fine spiral thickenings; radial bordered pits small, circular, widely separated, arranged in one row, with vertical, lenticular pit-openings; tangential bordered pits fairly small, circular with small vertical or slightly oblique pit-openings. Terminal and diffuse wood parenchyma entirely absent. Vertical resin canals scattered singly or tangentially grouped; epithelial cells often projected into canals, their walls very thick and pitted; canals large, often thin-walled thyloses present. Narrow rays, uniseriate or rarely biseriate in part, mostly 2-11 cells high, consisting of median parenchyma and marginal tracheids; median parenchyma often resinous, all walls fairly thickened, horizontal and tangential walls strongly pitted; pits on radial walls half-bordered, rather small, round or oval with oval or lenticular pit-openings, 1-5 in a cross field; marginal tracheids with fine spiral thickenings; bordered pits circular and small; ray margins sometimes projected vertically. Broad rays slender fusiform with horizontal resin canals; walls of epithelial cells rather thin; canals small or medium sized. Groups of stone cells in tangential bands in bark; walls very thick with numerous ramified or unramified, pit canals.

From Nesori, Namiuti Village, Ninohe District, Iwate Prefecture; the lower half of the Miocene; collected by S. WATARI in 1940; Nos. 31102, 31118.

#### *Taxodioxylon sequoianum* (MERCKL.) em. GOTHAN<sup>(1)</sup>

**Materials.** Nos. 31107-31114, 31116, 31119, 31120, 31124; all collected at Namiuti Village. Nos. 31148-31157; collected at Kozuya Village. All materials preserved

(1) GOTHAN, W. (1906).

excellently. They are much variable in size, usually 50 cm.–1 m. in diameter, the largest (No. 31114) reaching 2 m. in diameter and 7 m. in length.

Occurrence of this species from the Tertiary of our country has been repeatedly reported (SHIMAKURA 1933, 1934, 1936a; TAKAMATSU 1929; OHARA 1926) and there also occur a few closely allied species such as, *Taxodioxyton ishikuraense* TAKAMATSU (1926), *Sequoioxyton hondoense* YASUI (1917, 1928) and *S. miyagiense* YASUI (1928).

### *Fegonium hondoense* sp. nov.

(Figs. 2, 3; Photo. 2).

**Materials.** No. 31101; a well preserved, very hard silicified trunk with bark about 20 cm. in diameter; the following descriptions are chiefly based on this material. No. 31103; a long, hard, silicified wood, ca. 10 cm. in diameter; preservation good. No. 31104; a small silicified wood about 4.5 cm. in diameter and 3.5 cm. in length; preservation rather poor. No. 31105; a large silicified wood about 35 cm. in diameter; preservation rather good. No. 31123; a small, silicified and carbonized wood about 6 cm. in diameter and 25 cm. in length; preservation generally poor. No. 31125; a large silicified and carbonized wood about 50 cm. in diameter; preservation fairly good. All materials were collected at Nesori, Namiuti Village. Nos. 31101–31105 exposed in the cliff along the road; Nos. 31123, 31125 lying on the bed of the river Nesori.

### Description

*Growth rings* are distinct by size and disposition of vessels; breadth varies 1–2 mm. *Vessels* are numerous, gradually diminishing their size toward the late wood, and are scattered singly or grouped throughout the increment, when grouped, two to five, rarely more vessels are usually clustered in irregular forms, rarely in radial series; singly scattered vessels are especially numerous in the late wood (Fig. 3 A; Photo. 2 A, B). Pores are nearly round or rounded polygonal in outline; walls are rather thin; diameter of vessels in the early wood measures mostly 30–70  $\mu$  and the smaller ones in the late wood often less than 10  $\mu$ ; there are 237–329 vessels in 1 square mm. Vessel segments vary 400–1000  $\mu$  in length, both ends tapering to form relatively short tails; end walls place usually somewhat obliquely and are provided with simple perforation in the early wood (Fig. 3 B, 4 Aa; Photo. 2 D) and scalariform or partly reticulated scalariform in the late wood (Fig. 4 Ab–d), cross bars on an end wall numbering 10–15; pits on the lateral walls are bordered, usually scalariform or horizontally elliptical in outline and opposite in arrangement (v in Fig. 3 B; Photo. 2 D). Thyloses occasionally occur.

*Wood parenchyma* is small in quantity, scattered throughout the wood and rather thin-walled (p in Fig. 3 A). Parenchymatous cells arrange in a vertical series, individual elements measuring 10–20  $\mu$  in diameter and 50–130  $\mu$  in length (p in Fig. 3 B).



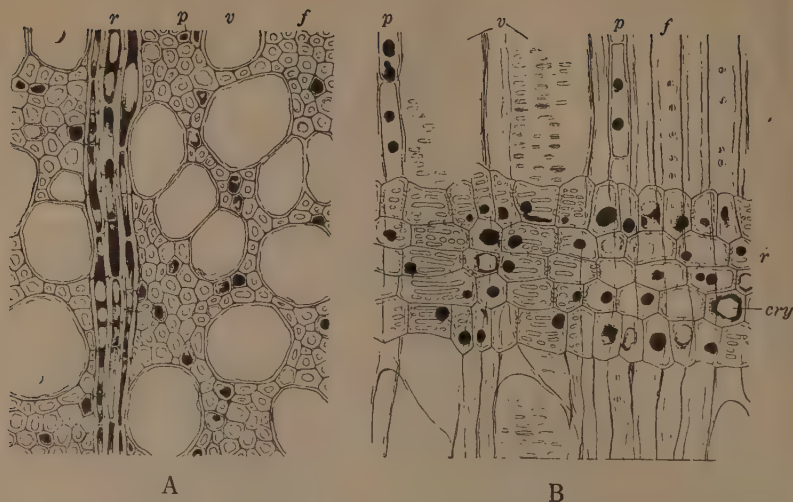


Fig. 3. *Fegonium hondoense* sp. nov. A, transverse section of a small part of the early wood. B, radial section of the early wood containing a heterogeneous uniseriate ray. v, vessel; f, wood fibre; p, wood parenchyma; r, ray; cry, crystal. ( $\times 220$ ).

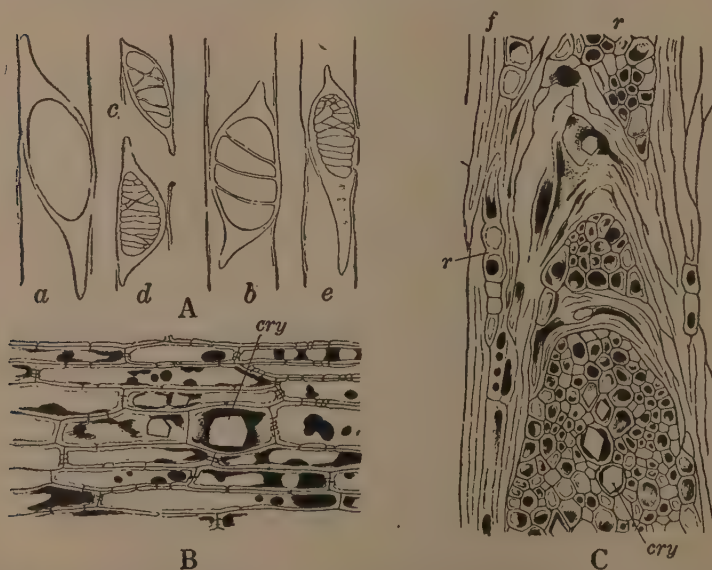


Fig. 4. *Fegonium hondoense* sp. nov. Aa-e, various forms of perforations on the vessel end walls in radial section. B, a part of inner layer of a multiserial ray in radial section. C, tangential section showing a few uniseriate and compound rays. Abbreviations as in Fig. 3. ( $\times 220$ ).

*Tracheids* are not found, if present they seem to be very few in number. *Wood fibres* are present abundantly; thick-walled and polygonal in tranverse section, frequently fine pits being clear; mostly 10–20  $\mu$  in diameter and 2.5–5  $\mu$  in membrane thickness; pits on the lateral walls are small, apparently bordered with vertical, slit-like openings and are arranged in a single row (*f* in Fig. 3 A, B).

*Medullary rays* are of three kinds, that is, uniseriate, multiseriate and compound. In tangential section uniseriate rays are linear and usually 5–10, sometimes 14 cells high; multiseriate rays are linear to fusiform and 2–6 cells wide and 15–50, rarely up to 80 or more cells high; compound rays are fusiform and very large, 10–20 cells wide and 100–200 or more cells high (Fig. 4 C; Photo. 2 E). In radial section uniseriate rays and the peripheral one to three layers of multiseriate and compound rays consists of squarish or polygonal, rather short cells; marginal cells are nearly equal in length and height, or slightly upright; median cells are nearly equal in length and height, or laterally elongated, their length being usually less than three times of their height (Fig. 3 B; 4 B). Their horizontal and tangential walls are strongly pitted (Fig. 3 B); pits into the vessels are scalariform, circular or elliptical in outline and opposite in arrangement (Fig. 3 B; Photo. 2 C). In tangential section, these ray cells adjacent to the vessels, vertically elongated squarish in shape. They frequently contain fairly large, simple crystals. Among the multiseriate rays, those of two or three, or often five or more cells wide are composed only of cells of such a nature. In the broader multiseriate and compound rays, however, the inner layers are composed of mixture of short and broad cells just mentioned and long, small and cylindrical, thick-walled elements provided with innumerable, fine, simple pittings on the all walls (Fig. 4 B, C).

### Affinity

From the description given above, it is clear that the present fossils is an angiospermous wood. The diffused porosity, the presence of a great number of solitary or clustered vessels, the gradual diminishing of vessel size in the late wood, the oppositely arranged scalariform, elliptical or round bordered pits on the lateral walls of vessels, the occurrence of both simple and scalariform perforations on the end walls of vessels, the scalariform, circular or elliptical pits in opposite arrangement between vessel and ray parenchyma, the presence of uniseriate, multiseriate and compound rays, the presence of crystals in the ray cells, and the presence of a less number of scattered wood parenchyma seem to be important characteristics in its identification, and judging from these respects there are no doubts that the present fossil is similar to

those of some living *Fagus* (RECORD 1919, KANEHIRA 1926, YAMABAYASHI 1938). Comparing these fossils with living species of *Fagus*, the abundant presence of crystal, the structure of rays and other features are especially identical with *F. crenata* BL., but the size of vessels are considerably smaller than the latter.

For the fossil woods related to *Fagus*, UNGER gave the generic name *Fegonium* (1842) and described *F. vasculosum* and *F. Salinarum*. These two species and *F. megapolitarum* HOFMANN (1883), however, were transferred to *Plataninium* by VATER (1884), who gave a new diagnosis to *Fegonium* and added; "Diese Gattung umfasst die *Fagus sylvatica* verwandten Hölzer", describing two species, *F. dryandraeforme* and *F. Schencki*, both from the Lower Senonian of Brunswick. Afterwards, were reported two other species, one *F. lignitum* from the Oligocene of Saxony by BECK (1886) and another *F. caucasicum* from the Eocene of Caucasus by FELIX (1894). As VATER described in the diagnosis of the genus; "Die Gefässe dieser Dikotylenhölzer steht fast immer einzelnen..." (p. 836); above mentioned species show mostly always singly scattered vessels. According to the descriptions and illustrations, these species apparently differ from the present materials in other details also.

In our country, *Fagoxylon hokkaidense* was reported by STOPES and FUJII (1909) from the Upper Cretaceous of Hokkaido. These authors used the generic name *Fagoxylon* under the reason; "The genus *Fegonium* of UNGER and FELIX, with which this plants has presumably some relationship, is of Tertiary age, and does not seem to agree entirely with our fossil" (p. 65), but EDWARDS (1931) noted that this fossil should be included in *Fegonium* and emendated it as *Fegonium hokkaidense*. This species shows considerable similarity in general features to my species but the arrangement and size of vessels and the structure of ray cells apparently differ from each other. SHIMAKURA (1933, 1936a) reported the occurrence of *Fegonium* sp. from the Tertiary of Miyagi and Kanagawa Prefectures and said that they are probably identical with the wood of *Fagus crenata*. The same author (1933) shows another form of *Fegonium* from the Tertiary of Niigata Prefecture.

There are no described species showing a similarity with my present fossils; thus the following diagnosis may be given under the name *Fegonium hondoense*.

## Diagnosis

### *Fegonium hondoense* sp. nov.

Dicotyledonous wood related to *Fagus*. Growth rings distinct. Vessels diffuse, rather thin-walled, scattered singly or clustered two to four or more, gradually diminishing towards boundaries of growth rings



in late wood; round or rounded polygonal in outline; mostly  $30\text{--}70\ \mu$  in diameter and  $400\text{--}1000\ \mu$  in length; 237–329 in 1 square mm.; perforations simple in early wood and scalariform in late wood; pitting between adjacent vessels bordered, scalariform or flattened elliptical in outline and arrange oppositely; thyloses occasionally present. Tracheids not distinct. Wood parenchyma scattered, small in quantity. Wood fibres thick-walled, polygonal in transverse section,  $10\text{--}20\ \mu$  in diameter and  $2.5\text{--}5\ \mu$  in membrane thickness; bordered pits on lateral wall small, arranged in one row, with vertical slit-like pit-openings. Medullary rays of three kinds, uniseriate, multiseriate and compound; uniseriate rays linear, usually 5–10 cells high; multiseriate rays 2–6 cells wide, 15–50 or rarely 80 or more cells high; compound rays very large, 10–20 cells wide and 100–200 or more cells high; marginal cells of these rays often slightly upright; cells of uniseriate rays and peripheral a few layers of multiseriate as well as compound rays relatively short and broad, often containing crystals; cells of inner layer of compound and multiseriate rays consisted of mixture of short and broad elements and thick-walled, much elongated, cylindrical ones; pits into vessels scalariform, circular or flattened elliptical, opposite in arrangement.

From Namiuti Village, Ninohe District; the lower half of the Miocene; collected by S. WATARI in 1940; Nos. 31101, 31103, 31104, 31105, 31123, 31125.

### *Acerinium iwatense* sp. nov.

(Fig. 5, Photo. 3).

**Materials.** No. 31106; a longitudinal half of decorticated silicified wood about 9 cm. in diameter and 15 cm. in length, exposed in the cliff along the road; preservation excellent; collected at Nesori, Namiuti Village; the following description is chiefly based on this specimen. No. 31122; a large, silicified trunk, more than 30 cm. in diameter, lying on the bed of the river Nesori; details of the structure preserved well, but elements are markedly deformed.

### Description

Boundaries of *growth rings* are hardly discernible in many parts, but sometimes are distinct by the presence of a few layers of fairly flattened elements; their breadth is variable, up to 10 mm. *Vessels* are relatively small in number, while fairly large in size, scattering evenly throughout the wood, or, occasionally, diminishing very gradually in size towards the end of a growth ring (Photo. 3 A). They are scattered singly or two to four are grouped; pores are oval in outline, fairly thick-walled, and  $20\text{--}140\ \mu$ , usually  $60\text{--}100\ \mu$  in diameter (Fig. 5 A; Photo. 3 B); they number 14–19, usually 18–40, averaging 29 in 1 square mm. Vessel segments measure  $200\text{--}920\ \mu$ , mostly  $380\text{--}600\ \mu$  in length; both ends

tapering more or less abruptly into long or short tails; end walls place more or less obliquely and are provided with simple perforations; bordered pits on lateral walls are crowded, oval in outline and alternate in arrangement; pit-openings are horizontally elongated oval in shape; inner surface of the walls are provided with fine but rather roughly coiled spiral thickenings (Fig. 5 B-D; Photo. 3 C, D). Occasionally vessels contain some irregular or diaphragm-like masses of black substances.

*Tracheids* are rather abundantly present. In transverse section they are polygonal with rounded corner in outline; distinction from the wood fibres is rather difficult, showing, however, slightly larger size compared with the latter; mostly  $15-25\ \mu$  in diameter and  $3-4\ \mu$  in membrane thickness (*tr* in Fig. 5 A). In longitudinal section distinction of the wood fibre is very clear by the presence of fine spiral thickenings and small, circular and alternate bordered pits with round pit-openings on the lateral walls (*tr* in Fig. 5 B, C).

*Wood fibres* are very abundant and uniformly distributed; usually  $10-20\ \mu$  in diameter; walls are very thick; pits on the lateral walls are arranged in one row, widely separated from one another and are provided with vertical slit-like pit-openings (*f* in Fig. 5 B, C).

*Wood parenchyma* is not so abundant in quantity and is scattered throughout the wood; walls are slightly thickened and pitted; black substances and simple crystals are often present in the lumina of some cells (Fig. 5 G). Several cells are arranged in a vertical sequence and those on the both ends are pointed (Photo. 3 C); individual elements are much variable in size, i.e.,  $8-25\ \mu$  in diameter and  $100-150\ \mu$  in length.

*Medullary rays* are evenly distributed; uniseriate and multiseriate; three to seven rays in breadth of 1 mm.; uniseriate rays in 1 square mm. number 7-12, 10.5 in average, and multiseriate rays in 1 square mm. 4-6, 4.7 in average, totally 13-17, 15 in average. Uniseriate rays are 1-9, mostly 2-3 cells high, consisting of horizontally or vertically elongated cells. Usually in accordance with the increasing of the height of rays, that of individual elements become lower, while the length of cells tend to increase. For example, in those only of one cell high the height often reaches more than four time of the length, e.g.,  $30 \times 130\ \mu$  in actual

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Photo. 3. *Acerinium iwatense* sp. nov. A, transverse section of the wood through five growth rings, showing faintly distinct growth rings, the arrangement of vessels and the presence of several broad rays. ( $\times 20$ ). B, the same, magnified. ( $\times 70$ ). C, radial section of a small part of wood, containing four vessels with simple perforations and spiral thickenings and three medullary rays. ( $\times 70$ ). D, tangential section of a small part of wood containing three vessels, several uniseriate and multiseriate rays. ( $\times 70$ ).

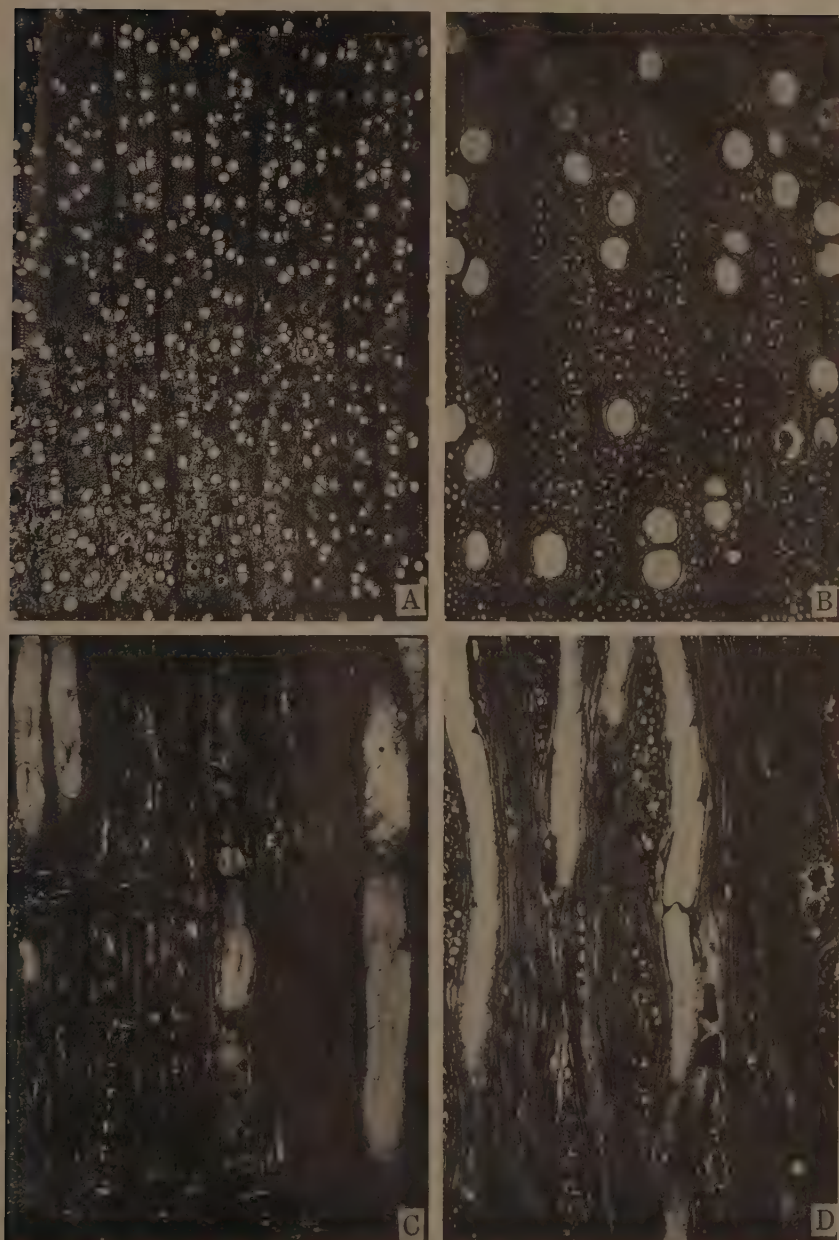


Photo. 3



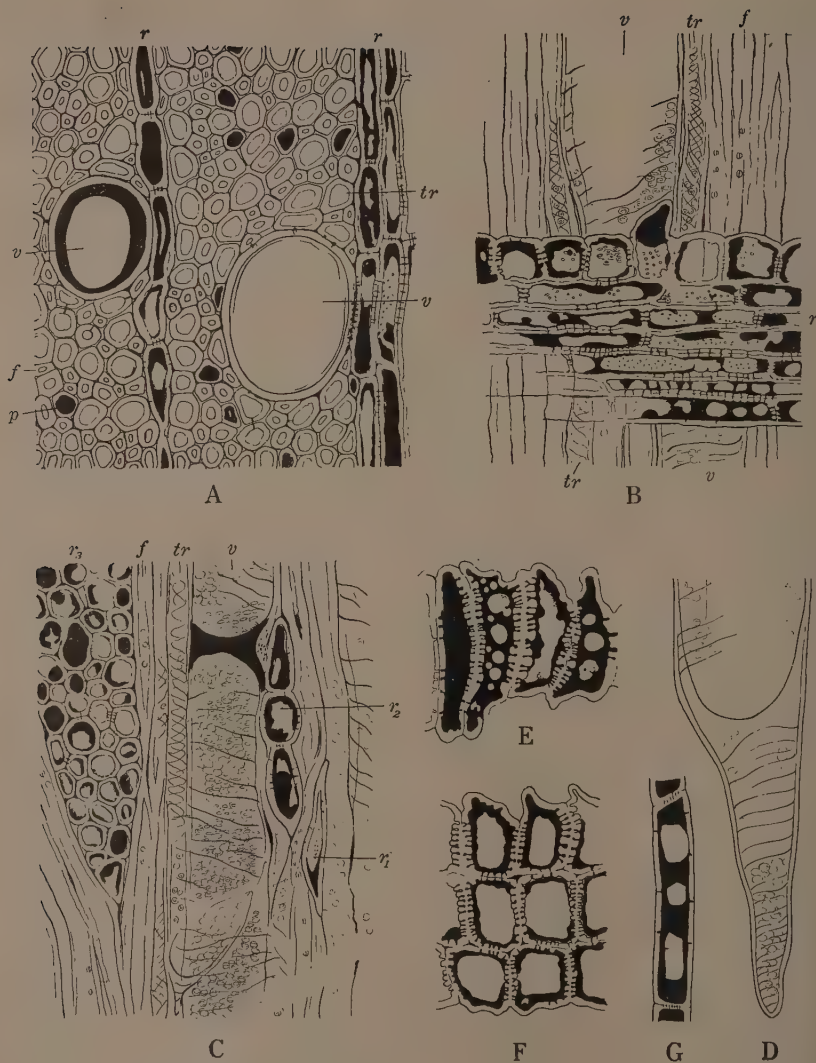


Fig. 5. *Acerinium iwatense* sp. nov. A–C, transverse, radial and tangential sections respectively of a small part of wood. D, showing the tapering end and a part of simple perforation of a vessel. E, radial view of a ray of three cells high. G, a crystal-bearing wood parenchyma. v, vessel; tr, tracheid; f, wood fibre; p, wood parenchyma; r, r<sub>1-3</sub>, medullary rays. (×220).

size (Fig. 5 B  $r_1$ , E), while in those of two or three cells high, both diameters are nearly equal or the former slightly exceeds the latter (Fig. 5 C  $r_2$ , F). In higher rays often all cells are procumbent, but the marginal cells tend to become higher (Fig. 5 B). Multiseriate rays are 3–7, mostly 4–6 cells wide and 1–38, mostly 13–28 cells high; median cells are long and procumbent, while the marginal ones sometimes become upright (Fig. 5 C  $r_3$ ). All walls of ray cells are very thickened and strongly pitted (Fig. 5 A, B, C, E, F); pits into a vessel are very numerous and apparently half-bordered (Fig. 5 B).

### Affinity

As is easily recognized from the description given above, the present specimens belong to a typical dicotyledonous wood. The diffuse porosity, the simple perforation on the end walls of vessels, and the presence of the spiral thickenings of vessels are considered as important features in their identification. These characteristics seem to occur in comparatively limited families among the living dicotyledones, namely, some Betulaceae (e.g. *Ostrya*), Protaceae, Rosaceae, Celastraceae, Aceraceae, Hippocastanaceae, Tiliaceae etc. (KANEHIRA 1926, YAMABAYASHI 1938, RECORD 1919, etc.). In these families, however, the vessels are usually very numerous excepting Proteaceae and Aceraceae. In this respects and in other characteristics, especially in the presence of crystals in the parenchyma, the present fossils strikingly agree with the latter, consequently with *Acer*.

According to previous works and my own observations on some living species of *Acer*, however, both the uniseriate and multiseriate rays are usually homogeneous and usually consist only of procumbent cells. The occasional presence of the upright cells seems to be found in a number of limited species. According to YAMABAYASHI (1938), such a condition is found rarely in *A. brevinerve* MAXIM., *A. aizense* NAKAI, *A. mandshuricum* MAXIM., *A. Pseudo-Sieboldianum* KOMAROV and *A. triflorum* KOMAROV. In my own observations, it is found in *A. crataegifolium* SIEB. et ZUCC., *A. distylum* SIEB. et ZUCC., *A. formosum* CARR., *A. mono* MAXIM. and its varieties, *A. japonicum* THUNB., *A. ornatum* CARR. var. *Matsumurae* KOIDZ. and *A. nikoense* MAXIM. Among these, that all elements of the lower uniseriate rays and the marginal cells of the higher uniseriate and multiseriate rays become higher occur with relatively frequency in *A. japonicum* and *A. nikoense*, while in other species such a condition seems to be very rare. In other features such as the abundant presence of crystal-bearing wood parenchyma of variable size, the present fossil is more similar to *A. nikoense*. But in some details there are slight differences.

Fossil woods related to *Acer* have been found since the Tertiary under *Acer* or *Acerinium* UNGER (1842) and seven species, including a few doubtful examples<sup>(1)</sup> were described by several authors (EDWARDS 1931), namely, *Acerinium danubiale* UNGER (1842) from the Tertiary of Upper Austria, *A. borussicum* CASPARY (1888) from the Tertiary (?) of East Prussia, *A. terraecoeruleae* CASPARY (1888) from the Tertiary (?) of East Prussia, *A. aegypticum* SCHENK (1888, 1890) from the Tertiary of Egypt, *A. astianum* PAMPALONI (1904) from the Tertiary of Piemont, *Acer* sp. (SZAFFER 1914) from the Pleistocene of Poland and *Acer* (FIETZ 1926) from the Prehistoric of Czechoslovakia. These species, however, apparently differ from the present specimens. In my present knowledge, there are no species which are rigidly coincide with the present fossils; thus the following diagnosis may be given.

### Diagnosis

#### *Acerinium iwatense* sp. nov.

Dicotyledonous wood related to *Acer*. Growth rings faintly distinct. Vessels evenly diffused, usually without tendency of diminishing of their size towards the boundaries of growth ring; scattered singly or two to four grouped; oval or round in outline, walls fairly thickened; 14–49, mostly 18–40 vessels in 1 square mm.; 20–140  $\mu$  in diameter, and 200–920  $\mu$  in length; lateral walls with alternately arranged, crowded oval bordered pits with horizontally elongated oval pit-openings; with spiral thickenings; perforations on end walls simple. Tracheids rather abundant; thick-walled polygonal with rounded corner in transverse section; with fine spiral thickenings; pits small, alternate, circular and bordered with round pit-openings; mostly 15–25  $\mu$  in diameter. Wood fibres mostly 10–20  $\mu$  in diameter, very thick-walled, with a row of separated, small, circular bordered pits with vertical, slit-like pit-openings. Wood parenchyma not so abundant, diffuse; 8–25  $\times$  100–150  $\mu$  in size; with crystals. Medullary rays uniseriate and multiseriate; 3–7 rays in breadth of 1 mm.; 13–17 rays in 1 square mm; uniseriate rays 1–9, mostly 2–3 cells high, consisting of short procumbent or upright elements; multiseriate rays 3–7, mostly 4–6 cells wide and 10–38, mostly 13–28 cells high; all elements

(1) PAX (1901) described, "Cfr. *A. borussicum* CASPARY et *A. terraecoeruleae* CASP. infra citata quae vix ad genus *Acer* pertinent. Radii medullares a cl. Caspary 5-6-serati describuntur, quod in speciebus recentibus nunquam occurrit," and UNGER also described the medullary rays in *Acerinium* are one to three cells in breadth. In living species of *Acer*, however, the occurrence of broader rays seems to be not seldom. According to YAMABAYASHI (1938) and KANEHIRA (1926), species showing 1-5 cells in ray breadth are quite usual and *A. mandshuricum* shows even 1-8. RECORD (1919) also describes that the rays in *A. saccharum* and *A. nigrum* reach 5-7 cells in breadth



long procumbent or with marginal cells of shorter or upright natures; all walls very thickened and strongly pitted; pits into vessels half-bordered and numerous.

From Nesori Village, Ninohe District; the lower half of the Miocene; collected by S. WATARI in 1940. Nos. 31106, 31122.

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## Studies on chromosome structure

### III. The spiral structure of *Trillium* chromosomes in fixed material

By Jiro IWATA

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With plate XII and 5 text-figures

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In the present paper, the result of observations made with fixed material, is reported as a complement to the result previously obtained with the acetocarmine smear method (IWATA, 1940 *a*). In the investigation, the observation was confined, as in the previous one, to the stages from the diakinesis to the end of the tetrad formation.

#### Material and method

Pollen mother cells of *Trillium Smallii* MAXIM. were used as material. The material was fixed with the modification of FLEMMING's stronger solution used in the previous investigations (IWATA, 1935, 1940 *b*). The sections were cut 14 micra thick, and stained exclusively with HEIDENHAIN's iron alum haematoxylin.

#### Observation

*Diakinesis.* The long prophasic chromosomes in the earlier stage become gradually contracted in length as the stage advances, and thus the individual chromosomes become recognizable distinctly in the diakinesis stage. The chromosomes in this stage stain deeply with haematoxylin. In these chromosomes the internal structure is hardly recognizable (NAITHANI, 1937). A double chromosome in diakinesis is shown in Text-fig. 1. The outline of this chromosome is not smooth, but wavyly corrugated (ALLEN, 1905). This wavy contour seems to indicate the internal spiral structure of the chromosome (NEBEL, 1932). The tetrad or quadripartite chromatid structure is obscure in this chromosome (HUSKINS and SMITH, 1935). In the double chromosome shown in Fig. 1, Pl. XII, however, the double chromatid nature is visible in the upper



member of the chromosome. Fibrous structures are seen projecting from the body surface of this chromosome (ALLEN, 1905). When the nuclear membrane disappears the chromosomes become arranged on one plane to form the equatorial plate.



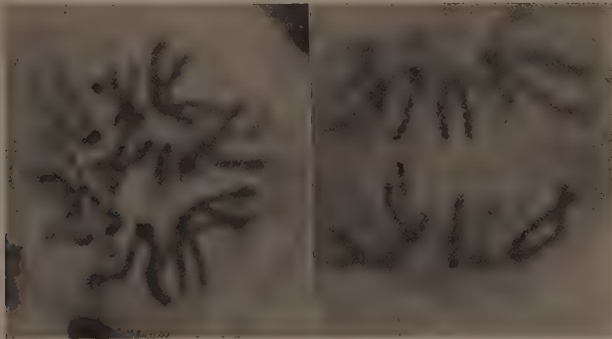
Text-fig. 1. A bivalent chromosome in diakinesis with corrugated outline.  $\times 1300$ .

*Metaphase I.* In the metaphase I, ten gemini are found in the equatorial plate (IWATA, 1940 *a*). Each two members of five gemini out of the 10 are shown separately in Fig. 2, *a*, *a'*, *b*, *b'*, *c*, *c'*, *d*, *d'*, *e* and *e'*. The spiral structure is clearly seen in each chromatid of these chromosomes. The spirals are mostly of the regular form and large in diameter. These spirals are the major spirals (FUJII, 1926; KUWADA, 1932; KUWADA and NAKAMURA, 1933, 1938; SINKE, 1934; MATSUURA, 1934; DARLINGTON, 1935; SHIMAKURA, 1937; NAITHANI, 1937; IWATA, 1940 *a*). In the proximal region of the chromosomes, the spirals are found not infrequently drawn out more or less extensively (Figs. 2, *c*, *d'*, 4 and 5). They are also often found drawn out at the points near the interstitial chiasmata. In the chromosome shown in Fig. 3 the spiral structure is obscured by the presence of the chromosome matrix. In the geminus shown in Fig. 4 the tetrad structure is clear, while it is obscure in those of Figs. 2 and 3 (SAX, 1930; NAITHANI, 1937; SHIMAKURA, 1937). This structure is not uniformly demonstrable in every geminus and through its whole length. In the geminus shown in Fig. 5 the double chromatid structure is presented only in part in its lower member.

In regard to the direction of coiling of the spirals, there is found no relation between the two homologues. While in some cases the two homologues have the spirals of the same direction, both being right handed (Fig. 2 *c'*) or left handed (Fig. 2, *c* and *d'*), in others as shown in Fig. 2, *b'*, *d* and *e'*, the direction is opposite in the two homologues (SAX, 1930; DARLINGTON, 1932; NAITHANI, 1937). In the geminus shown in Fig. 2 *a*, the direction is the same in the corresponding parts of the two homologues, being, in both, left handed in the part on the upper side of the chiasma and right handed on the lower side. In the cases shown in Fig. 2, *a'* and *e*, on the other hand, it is opposite on the left hand side of the chiasma, while on the right hand side it is the same, being right handed (*a'*) or left handed (*e*) in both homologues. The reversal in direction of coiling is, as has been reported by many authors, usually found to occur at the point of spindle fibre insertion or of an interstitial chiasma (Fig. 2, *a*, *a'*, *d*, *e*; SAX, 1930; TAYLOR, 1931; NEBEL, 1932; SAX and HUMPHREY, 1934; HUSKINS and SMITH, 1935; MATSUURA,

1935 *b*; IWATA, 1935; NAITHANI, 1937 *b*). Not infrequently, however, it occurs also at points other than the spindle fibre insertion or the interstitial chiasmata (Fig. 2 *b*; SAX, 1930; IWATA, 1935; HUSKINS and SMITH, 1935; MATSUURA, 1935, 1937 *b*). In Fig. 2 *b* the spirals are of opposite directions in the two homologues, in the parts outside of the two interstitial chiasmata, and of the same direction, being left handed in both homologues, in the middle part between the chiasmata. In regard to the direction of coiling, no definite relation can be found between the sister chromatids. In Fig. 5, the spirals of these chromatids are of the same direction, while in Fig. 6 they are of opposite directions. In Fig. 7, while the spirals are of the same direction, both being right handed, in the lower parts of the two chromatids, in the upper parts they are coiled in opposite directions. In Fig. 8 in which a telomitic bivalent chromosome is shown, all the four chromatid spirals are right handed, hence of the same direction.

*Anaphase I.* When the chromosomes begin to enter the anaphasic stage the tetrad nature of the chromosomes becomes evident. Text-fig. 2 is the polar view of an early anaphase. At this stage most of the



Text-figs. 2-3. 2. Polar view of an early anaphase I showing the tetrad structure of the bivalents. 3. Side view of late anaphase I showing the spiral structure of chromosomes.  $\times 1300$ .

chromosomes which are atelomitic present the form of a double V and the telomitic chromosomes that of the single V, having their apices pointing to poles. In Text-fig. 3 the side view of the middle anaphase is shown. In this figure the chromosomes show the spiral structure. Usually the chromosome matrix is not seen clearly in the anaphase. Seven chromosomes in the anaphase I are shown separately in Figs. 9-15. As seen from these figures, the spirals are of a more or less compact form and the spiral pitch is as short as in the case of metaphase I (except the chromosome in Fig. 9). Occasionally, however, the spirals are drawn

out considerably. A chromosome drawn out to a considerable extent is shown in Fig. 9. Here, the spiral structure is lost to sight. As commonly occurring in certain species of *Lilium* (KATO and IWATA, 1935) the spirals are also often found drawn out in the proximal region (Figs. 10 and 11). In Fig. 10 the spirals of the two chromatids are drawn out in the proximal region to a nearly corresponding extent, and the minor spirals are visible in the drawn out parts. In Fig. 11 the spiral of the chromatid on the left hand side is more extensively drawn out than that of the other chromatid. The spiral may also be drawn out in other regions which may or may not correspond in the two sister chromatids. In the anaphase chromosomes too, there is found no definite relation between the sister chromosomes in regard to the direction of coiling. In the telomitic chromosome shown in Fig. 11 the direction is the same in the two chromatids, being right handed, though the number of the spiral turns is fewer in the left hand chromatid than in the other. In the case of Fig. 12, it is opposite in the two chromatids. In the atelomitic chromosome shown in Fig. 13 the spirals of the two outside arms of the chromatids are of the same direction, both being right handed, and in the remaining two lying between them they are of opposite directions. The reversal in direction of coiling is usually found to occur at the spindle fibre insertion (SAX, 1930; TAYLOR, 1931; NEBEL, 1932; SINKE, 1934; HUSKINS and SMITH, 1935; IWATA, 1935; MATSUURA, 1935, 1937 *a* and *b*). Not infrequently, however, the point of reversal can be found to lie between the spindle fibre insertion and the distal end of the chromatid (HUSKINS and SMITH, 1935; IWATA, 1935; MATSUURA, 1935, 1937). In the chromosomes reproduced in Figs. 10, 15 (telomitic) and 11 (atelomitic), the reversal point found between the spindle fibre insertion and the distal end of the chromatid is shown (being indicated by arrows). The numerical result obtained of the direction of coiling in the chromosomes in anaphase I is given in Tables I and II.<sup>(1)</sup>

TABLE I. The case of telomitic chromosomes.

Types	R-L	L-L	R-R	Total
No. of chromosomes observed	15	13	7	35

(1) In Table I (the case of telomitic chromosomes), each of R and L represents a chromatid, and in Table II (the case of atelomitic chromosomes), each represents one arm of the chromatid. In both tables, R denotes the dextrorse, L the sinistrorse and "—" the spindle fibre insertion. The same notations will be used also in the description and other tables.

TABLE II. The case of atelomitic chromosomes.

Types	R-R-R-L	R-R-R-R	L-L-L-L	R-L-L-L	R-R-L-L	Total
No. of chromosomes observed	3	2	1	1	1	8

In regard to the reversal occurring between the insertion point and the distal end of the chromosome, the following results were obtained. In the case of telomitic chromosomes, the results were:  $R_7-R_{3.5}+L_{3.5}$ ,  $R_7-L_{2.5}+R_{4.5}$ ,  $R_9-L_{4.5}+R_{4.5}$ ,  $L_6-L_{2.5}+R_{3.5}$ ,  $R_{2.5}+L_{4.5}-L_{3.5}+R_{2.5}$  and in the case of atelomitic chromosomes, it was:  $R_6-R_{3.5}+L_{2.5}-L_5-L_4$ ,  $L_7-L_6-R_6-R_{3.5}+L_{3.5}$ . Here, the suffix figures denote the numbers of spiral turns and the mark + the reversal point. These results show that the ratio between the numbers of turns found on both sides of the reversal point varies in different cases indicating that the reversal can occur at any point between the spindle fibre insertion and the distal end of the chromatid, and that it can occur at different points in different chromatids or chromatid arms of a chromosome.

The data may not be sufficient to draw any decisive conclusion, but they are in accordance with the cases of certain species of *Trillium* (MATSUURA, 1935) and *Lilium* (IWATA, 1935). In the spiral of the left hand side chromatid arm shown in Fig. 14 the tertiary split was observed with a certain distinctness (HUSKINS and SMITH, 1935; IWATA, 1940 a).

*Telophase I.* In the early telophase when the chromosome reaches the poles the spirals are usually drawn out to a certain extent. The chromosomes in this stage are shown in Text-fig.

4. When the nuclear membrane becomes noticeable the chromosomes become markedly shortened and the regular form of the spirals in which their turns are rather close together is recovered (Fig. 16; KATO and IWATA, 1935; IWATA, 1935; NAITHANI, 1937). As the stage proceeds further, the chromosomes become shortened more remarkably (Fig. 17). The reticulate-like appearing structure of the chromosomes which is observed in this stage with the acetocarmine smear method (IWATA 1940 a) is not observable in the fixed material. In most cases, the two chromatid spirals of more or less regular form are found closely compressed together in the form of one thick thread spiral (major spiral) as in the case of metaphase I. In the late telophase the



Text-fig. 4. Telophase I showing the spirals drawing out.  $\times 1300$ .



tertiary split is perceptible more or less clearly in places (HUSKINS and SMITH, 1935).

*Interkinesis.* A nucleus in the interkinesis is reproduced in Fig. 18. In this figure it is seen that the spirals are not markedly drawn out in this stage and the chromosomes are as nearly short as those in metaphase I. Generally, the spirals are of the regular form as in metaphase I. No "reticulate" structure of chromosomes is found in this stage, though occasionally, some of the chromosomes present a structure which resembles the structure of the nucleus of *Tradescantia* in this stage (Fig. 15, IWATA, 1940 a).

*Prophase II.* When the nucleus enters the prophase of the second division, its volume is increased. The chromosomes also become thicker to a certain extent as the stage advances. Figs. 20 and 21 show the chromosomes in the second prophase. The chromosome in Fig. 21 is slightly more advanced in stage than that shown in Fig. 20, and the coiled thread is somewhat thicker in this chromosome than in the other. In some cases, very thick chromosomes are observed in the late prophase (Fig. 22). The chromosomes immediately after the disappearance of the nuclear membrane are shown in Fig. 23. In general, the spirals at this stage are of regular form as in the case of metaphase I, though they often show a form somewhat drawn out.

*Metaphase II.* In the metaphase all the chromosomes are arranged on the equatorial plane. The telomitic chromosomes are of the single V form and the atelomitic ones the double V, with the apices pointing to the center of the chromosome plate. In this stage the chromosomes are short and the spirals are of the regular form as in the case of metaphase I, presenting a marked resemblance to the chromosomes in metaphase I. In some preparations the minor spirals were often observed in the form of corrugations (Fig. 24; DARLINGTON, 1935; KUWADA and NAKAMURA, 1938; IWATA, 1940 a). The major spirals are drawn out not infrequently near the insertion point as in the case of anaphase I, and in some cases in the part between the spindle fibre insertion point and the distal chromosome end (Fig. 25). In the parts of chromosomes being drawn out considerably, the minor spirals are clearly observable (Fig. 26; KUWADA and NAKAMURA, 1934; KATO and IWATA, 1935; IWATA, 1935; OURA, 1936). In the metaphase II also, there is no definite relation between sister chromatids in regard to the direction of coiling of the spirals, as in the case of anaphase I. In the telomitic chromosome shown in Fig. 24, the spirals of the two chromatids are of the same direction, both being left handed, while in that shown in Fig. 27 they are of the opposite directions. In the atelomitic chromosome shown in Fig. 26, the spirals in the two right hand side arms of the chromatids are of the

same direction being left handed, while they are of opposite directions in the other two arms on the left hand side of the figure. In this case, therefore, the point of reversal is found at the spindle fibre insertion. In some cases, however, as in the case of the first division, the reversal point lies between the spindle fibre insertion and the distal end of the chromosome. An example of this is shown in Fig. 25 (indicated by an arrow).

The results of observation of the direction in coiling in the metaphase II are given in Tables III and IV.

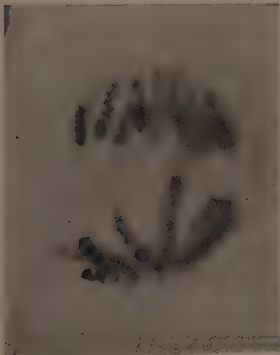
TABLE III. The case of telomitic chromosomes (single V's).

Types	R-L	L-L	R-R	Total
No. of chromosomes observed	19	17	4	40

TABLE IV. The case of atelomitic chromosomes (double V's).

Types	L-L-L-R	R-R-R-R	R-R-R-L	R-L-L-L	Total
No. of chromosomes observed	6	2	2	2	12

As seen from the tables, the results are nearly the same as those obtained in the anaphase I. For the case of the reversal occurring at a point between the spindle fibre insertion and the distal chromosome end, the following results were obtained in the telomitic chromosomes:  $L_6-R_{3.5}+L_{3.5}$ ,  $L_6-L_{2.5}+R_{8.5}$ ,  $R_8-L_{3.5}+R_{4.5}$ . The results show that in all these cases the points of reversal are on different levels in the sister chromatids.



Text-fig. 5. Side view of anaphase II showing the spiral structure of chromosomes.  $\times 1300$ .

*Anaphase II and telophase II.* The chromosomes in the late anaphase are shown in Text-fig. 5. In this stage the chromosomes are short and the spirals are of regular form as in the case of anaphase I. A nucleus in the early telophase is shown in Fig. 28. In this nucleus it is seen that the spirals are of more or less regular forms. No "reticulate" structure is observed in the chromosomes. As the stage proceeds further, the spirals are drawn out first at the distal end of the chromosome, being gradually rendered irregular throughout (KUWADA and NAKAMURA, 1938; IWATA, 1940 a).

## Conclusion

In the present investigation, it was observed that the major spirals exist in the chromosomes in both first and second divisions, and that the spiral threads appear to be solid in many cases, the minor spirals being not clearly observable, which were revealed in the previous investigation, with the acetocarmine smear method (IWATA, 1940 *a*). We may thus conclude that in the fixed material the minor spirals are concealed though they really exist, hence, that the major spirals are not simple spirals, even if they appear so, but really double-coiled spirals. In fixed material the minor spirals are visible only in the part where the major spirals are drawn out. In this plant the major spirals are visible also in the interkinesis without much change from those in the first and second divisions, and, therefore, the major spiral structure or the double coiled structure in the first metaphase is maintained through interkinesis up to the end of the second division.

The reticulate structure of chromosomes which is observable with the acetocarmine smear method is not observed in the fixed material. With the fixation method, the chromosomes show a clear spiral structure in most case. This seems to be due to a close association of the spirals in the chromosome into a seemingly single thick thread spiral of regular form (cf. KUWADA and NAKAMURA, 1938). In accordance with this conclusion, the tertiary split which is visible with a certain distinctness with the acetocarmine smear method is generally concealed.

The problem of the direction in coiling of the chromonema spirals has been studied by a number of investigators (SAX, 1930; ISHII, 1931 *a*, *b*; NEBEL, 1932 *b*; SINKE, 1934; HUSKINS and SMITH, 1935; NEBEL and RUTTLE, 1935; MATSUURA, 1935, 1937 *a*, *b*; IWATA, 1935; NAITHANI, 1937). ISHII (1931 *a*, *b*) has concluded that in *Hosta* and some other plants the spirals of the two homologues are coiled in the same direction in the metaphase I. SAX (1930) has, on the other hand, observed cases where the spirals of the two homologues appear to be coiled in opposite directions. DARLINGTON (1932) has expressed the view that the spiraling commences at the attachment constriction, resulting in the formation of spirals coiling in opposite directions on both sides of the constriction. In the present investigation both cases were observed, one of which is in accord with the view of SAX and the other of which might appear to be in favour of DARLINGTON's view. Other possible cases were also observed, in some of which the reversal in coiling direction may have its causal relation to the presence of interstitial chiasmata (NEBEL, 1932; SAX and HUMPHREY, 1934; MATSUURA, 1935; IWATA, 1935). We are at present not in a position to judge what causes the reversal to occur, but

it seems highly probable that it can occur in any chromosome or chromatid and at any point.

### Summary

1. In *Trillium* the chromosomes in metaphase and anaphase are of the double-coiled structure in the second division as well as in the first division. The chromosomes of this structure in the first metaphase pass through the interkinesis to the second metaphase without undergoing any remarkable change in the mode of coiling.

2. In fixed material the minor spirals are demonstrable only in the parts where the major spirals are drawn out.

3. In the early metaphase I, the tetrad structure is obscured by a close association of the sister chromatid spirals into a seemingly single spiral.

4. The spirals are often found drawn out at the region near the insertion point, and also in the region between the spindle fibre insertion point and the distal chromosome end.

5. Occasionally, the spirals are observed drawn out also in the interkinesis to a considerable extent.

6. In fixed material no chromosomes presenting a reticulate structure are observed in the stages from the diakinesis to the end of the tetrad formation, probably owing to the fact that the spirals contained in the chromosome are so closely compressed together as a result of fixation that they present the appearance of a single spiral.

7. The direction of coiling is not fixed in definite chromosomes. The spirals in the two homologues may be of the same direction or opposite directions.

8. The direction of coiling may also vary in the two sister chromatids. The two spirals may be coiled in the same direction or in opposite directions.

9. A reversal in direction of coiling is frequently observed which occurs at the point of spindle fibre insertion as well as at chiasmata.

10. The reversal occurring at points other than the point of the spindle fibre insertion or the chiasmata is also observed not infrequently.

11. The point of reversal occurring in the part between the point of spindle fibre insertion and the distal chromosome end is usually found on different levels in the two sister chromatids, both in anaphase I and in metaphase II.

12. The "tertiary split" is observed in the anaphase I.

In conclusion the writer wishes to express his cordial thanks to Prof. Y. KUWADA for his suggestions and criticisms throughout the course of the investigation.

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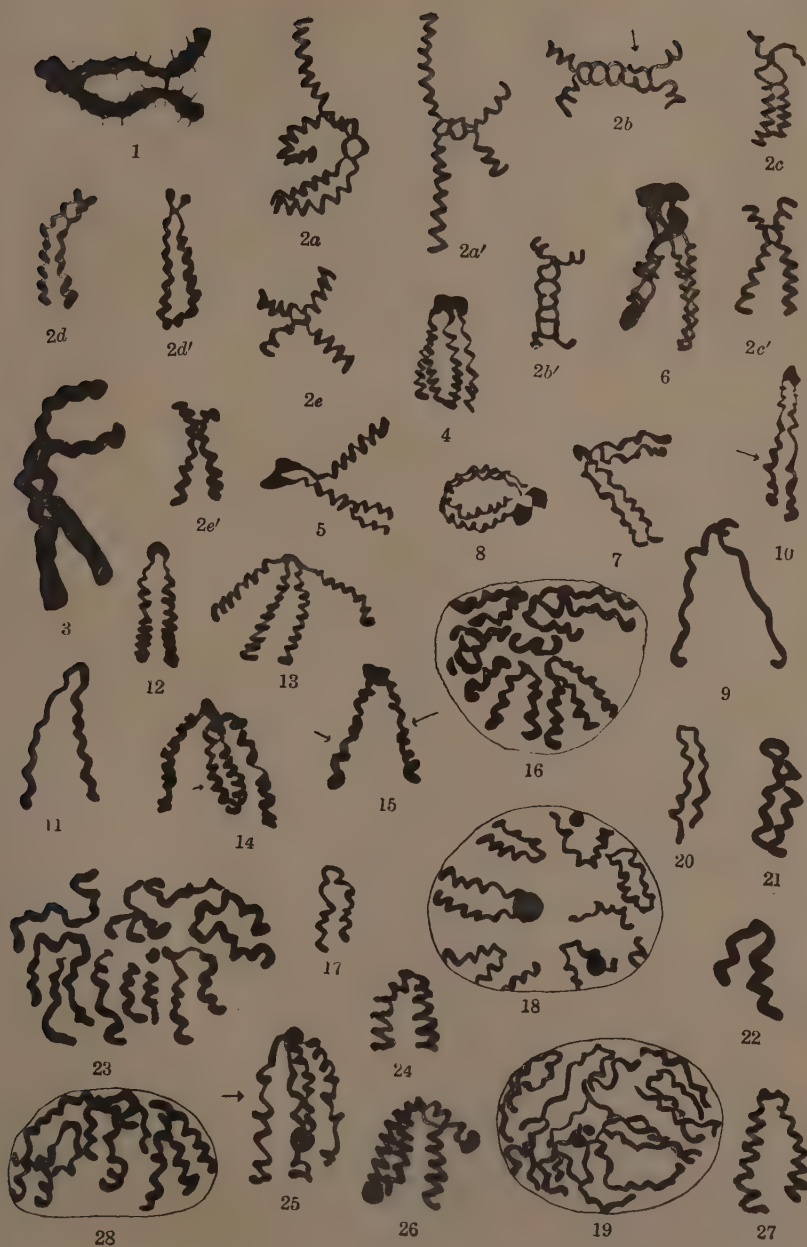
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### Explanation of plate XII

All the figures are drawn with the aid of ABBE's camera lucida using ZEISS' homog. imm. 1/12 and comp. oc. 15 $\times$ .

- Fig. 1. Bivalent at diakinesis.
- Fig. 2. Showing each member of five bivalents at metaphase I separately.
- Fig. 3. A bivalent in metaphase I, consisting of the members with matrix substance.
- Fig. 4. The same showing clearly its tetrad nature.
- Fig. 5. A telomitic bivalent, in one of the members of which it is seen that the spiral is a double-stranded one.
- Fig. 6. The same showing the two chromatids in one of the members, with coils of opposite directions.
- Fig. 7. The same showing the case of the two chromatids of one member (lower in the figure) with coils of the same direction and those of the other (upper) with coils of opposite directions.
- Fig. 8. The same showing the four chromatids with the spirals coiling in the same direction, being all right handed.
- Fig. 9. A chromosome in anaphase I with the chromatid spirals drawn out.
- Figs. 10 and 11. The same showing the chromatid spirals drawn out in the proximal regions.
- Fig. 12. The same showing the reversal in direction of coiling occurring at the insertion point.
- Fig. 13. The same showing the two inner chromatids with the spirals coiling in directions opposite to each other and the two outer ones with ones of the same direction (dextrorse).
- Figs. 14 and 15. The same showing the reversal in direction of coiling occurring between the insertion point and the distal end of the chromosome.
- Fig. 16. Chromosomes in an early telophase I.
- Fig. 17. Late telophase I.
- Fig. 18. Interkinesis.
- Fig. 19. The same with the chromosome spirals unusually drawn out.
- Figs. 20, 21 and 22. Homotype prophase chromosomes.
- Fig. 23. Homotype prophase just after the disappearance of the nuclear membrane.

- Fig. 24. A metaphase II chromosome (telomitic) showing the minor spiral.
- Fig. 25. The same (atelomitic) with the spirals partially drawn out.
- Fig. 26. The same with three arms showing the left handed coils and the remaining one the right handed ones.
- Fig. 27. The same (telomitic) showing the two chromatids with the coils of opposite directions.
- Fig. 28. Showing one of the tetrad nuclei.
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## Studies on chromosomal structure

### IV. Observation of pollen mother cells in *Lilium japonicum*, THUNB.

By Jiro IWATA

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With plate XIII and 24 text-figures

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(Received July 16, 1941)

In *Lilium japonicum* the behaviour of the chromonemata in the second division varies in different cases, probably under the influence of environmental conditions. While in some cases the chromosomes are of the double-coiled structure, in others they are of the single-coiled structure. To obtain some accurate knowledge on the variation of the chromonema behaviour the present investigation was undertaken.

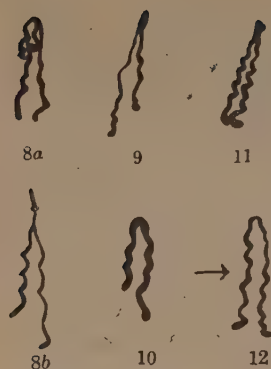
#### Material and method

Pollen mother cells of *Lilium japonicum*, THUNB. were used as material. Some material was collected in the suburbs of Kyoto and the rest was obtained from the plants transplanted in pots from the field in the preceding summer. Anthers were fixed with the modification of FLEMMING's solution used in the previous investigations (IWATA, 1935, 1940 *b*). Sections were cut 14 micra thick and stained exclusively with HEIDENHAIN's iron alum haematoxylin. For comparison some observations were also made with the acetocarmine smear method.

#### Observation

In the present investigation the observations were made in the stages from the first metaphase to the end of the tetrad formation.

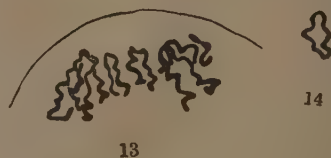
*Metaphase I.* In metaphase I twelve gemini are counted in the equatorial plate. In fixed preparations the spiral structure is mostly obscure in this stage. The chromosomes usually show the corrugated outline, suggesting their internal spiral structure (Text-fig. 1; TAYLOR, 1931; NAITHANI, 1937). In some cases when the differentiation is satisfactory, however, the spiral structure can be observed with a certain



Text-figs. 8-12. Chromosomes in anaphase I.  $\times 1300$ . 8-9. Showing the spirals drawn out. 8 and 11. Showing the reversal in direction of coiling of the spirals occurring at the insertion point. 12. Showing the reversal occurring at a point between the spindle fibre insertion and the distal end of the chromosome.

*Telophase I.* When the chromosomes reach the poles, they are seen still to be in the elongated state to some extent. At a slightly later stage, however, they become shortened and their spirals come to take the regular form again. Soon, however, the spirals undergo the drawing out which takes place conspicuously, beginning at the distal end and proceeding further towards the proximal region (KATO and IWATA, 1935; IWATA, 1935; NAITHANI, 1937). The chromosomes just before the formation of the nuclear membrane are shown in Text-fig. 13. In this figure the chromosomes are short in length and the spirals are drawn out irregularly. As the stage advances, and the chromosomes draw together closely, they are shortened in length further and further, and the spirals become larger and larger in

In regard to the direction of coiling of the chromatid spirals in the anaphase I, there are three types, namely L-L, R-R and R-L.<sup>(1)</sup> In Text-figs. 5 and 10, the two sister chromatid spirals are of the same direction, being both dextrorse (Text-fig. 5), or both sinistrorse (Text-fig. 10). In Text-fig. 11 the direction is opposite in the two chromatids. Usually the reversal in direction of coiling takes place at the insertion point, but this is not always the case. In some cases it occurs in the region between the point of spindle fibre insertion and the distal chromosome end (Text-fig. 12; HUSKINS and SMITH, 1935; IWATA, 1935; MATSUURA, 1935, 1937). In the middle anaphase, the chromosomes are often found markedly drawn out. In the left hand side chromatid of the middle chromosome shown in Fig. 3, it is shown that in the proximal region the major spiral is almost completely drawn out, while in the distal region it maintains its regular form unchanged.



Text-figs. 13-14. Chromosomes in telophase I, showing their spirals drawn out.  $\times 1300$ .

(1) L and R denote one of the sister chromatids respectively, and L is used when the spiral of the chromatid is sinistrorse in direction of its coiling, and R is used when the spiral is of dextrorse coiling. The mark "—" denotes the point of spindle fibre insertion.

diameter, finally to be not distinguishable individually. A chromosome in the late telophase is shown in Text-fig. 14, which is quite short and in which the major gyres are transformed into an undulating form. Meanwhile the nuclear membrane becomes visible. The nucleus is at first small in size and situated near the surface of the cell. It becomes then larger and larger and moves towards the center of the cell as the stage advances. In acetocarmine preparations the chromosomes in the daughter nuclei thus formed usually show some reticulate structure as a result of the spirals being considerably loosened and of irregular forms, though each chromosome still maintains its boundary more or less distinctly (Fig. 4).

*Interkinesis.* In the interkinesis the nucleus is somewhat larger than in the late telophase. In this stage a further change in form of the spirals takes place, and in the acetocarmine preparations the chromosomes present so complex an appearance as to form the reticulate structure of the nucleus (Fig. 5). This complex

appearance seems due to the fact that the two spirals in the chromatids as a result of the tertiary split become separated from each other in this preparation. In the fixed material from the field (in the suburbs of Kyoto), the major spirals are not completely drawn out, so that the spiral aspect is still perceptible in places (Text-fig. 15). In the fixed material from the plants transplanted in pots in the preceding summer, on the other



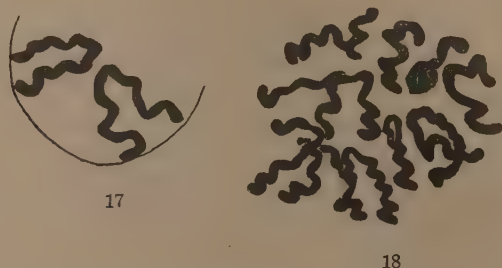
Text-figs. 15-16. Nuclei in interkinesis.  $\times 1300$ . 15. From the material collected from the field. Major spirals are visible in places. 16. The same from pots. Showing the minor spirals only.

hand, the major spirals are completely drawn out, and the single-coiled spirals of irregular forms which run sinuously throughout the whole nuclear cavity are visible in the interkinesis as in the case of *Zebrina*, *Rhoeo* and some other plants (Fig. 6 and Text-fig. 16; SINKE, 1930).

*Second prophase.* When the nucleus enters the prophase of the second division, it becomes larger and larger. The major spirals in the preceding telophase become again more clearly recognizable in the early prophase than in the interkinesis, and the chromaticity of the chromosomes is increased gradually. Two chromosomes in the second prophase are shown in Text-fig. 17. These chromosomes are thick, and in one of them the major spirals are visible in a more regular form than in the other. In the material collected from the field the coiling of the major spiral is still more regular. A nucleus in the middle prophase is shown in Fig. 7.



In this nucleus the major spirals are perceptible with a certain distinctness. Fig. 8 shows a later stage than Fig. 7. In this figure, one of the chromosomes which is indicated by an arrow shows the major spiral coiled so compactly, that the chromosome resembles, so far as the internal structure is concerned, very much those of anaphase I. The chromosomes in the stage just before the disappearance of the nuclear membrane are

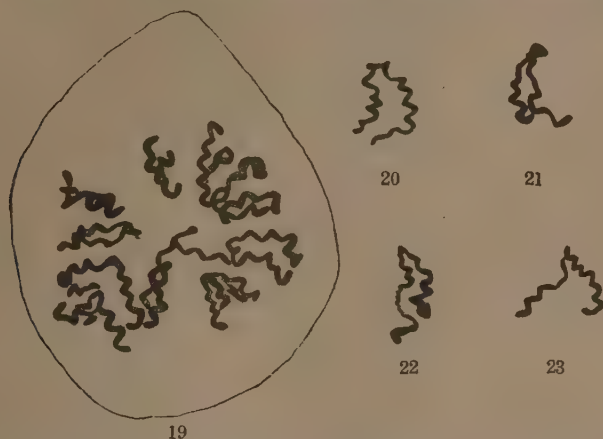


Text-figs. 17-18. Chromosomes in homotype prophase.  $\times 1300$ .  
17. Early prophase. 18. Late prophase.

shown in Text-fig. 18. In some of them, the spirals are coiled regularly and one of them presents as regular a form as those in anaphase I. In the material from the plants planted in pots, no spirals coiled so regularly and compactly are observed in the second prophase. In this material the major spirals are completely drawn out in the interkinesis, and the spirals of single-coiling develop to form the metaphase chromosomes (cf. *Zebrina*, *Rhoeo*, SINKE, 1930; *Tradescantia*, KATO, 1935; *Hyacinthus*, NAITHANI, 1937).

*Metaphase II.* The chromosomes in metaphase II are reproduced in Text-fig. 19. In these chromosomes, the spiral structure is visible clearly. In most of them, the spirals are larger in diameter than in the preceding prophase and are regularly coiled as in the case of anaphase I. The spirals are, however, often drawn out near the proximal region of the chromosome (Text-fig. 20), and also in the region between the point of spindle fibre insertion and the distal chromosome end. In Text-fig. 21, the major spiral is almost completely drawn out in the right hand chromatid, while in the distal end of the other, the coiling is maintained to a certain extent. In Text-fig. 22 the minor spiral is visible in the middle region of the left hand chromatid where the major spiral is drawn out almost completely. In acetocarmine preparations the major spirals are visible clearly. The chromosomes in the second metaphase from the acetocarmine preparation are reproduced in Fig. 9. Almost all the chro-

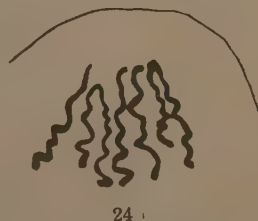
mosomes in this metaphase show the major spirals. In the material from pot plants, however, the chromosomes in this stage show the single-coiled structure (Fig. 10). In *Lilium japonicum*, therefore, there are in meta-



Text-figs. 19-23. Chromosomes in metaphase II.  $\times 1300$ . 19. Polar view showing the major spirals. 20. Showing the spiral drawn out in the proximal region. 21. Showing one of the spirals (on the right hand side) drawn out. 22. Showing the minor spirals seen in the drawn out part of the major spiral. 23. Showing the asymmetrical drawing out of the spirals.

phase II two types of chromosomes in regard to the mode of coiling, i.e. the type of chromosomes with the double-coiled spiral structure and the type of chromosomes with the single-coiled spiral structure. Intermediate types are often observed also. The tertiary split is perceptible in one of the chromosomes shown in Fig. 11, which is indicated by an arrow. In regard to the direction of coiling of the spiral there is found also no relation between the sister chromatids. While in the chromosome shown in Text-fig. 20, the direction is the same in the two chromatids, it is opposite in the case shown in Text-fig. 23.

*Anaphase II and telophase II.* Text-fig. 24 shows the chromosomes in the second, anaphase. In these chromosomes the spirals are drawn out considerably, mostly in the proximal region of the chromosomes, and in some also in the distal region. In this stage the double-coiled structure of the chromosomes is demonstrable in acetocarmine preparations, as



Text-fig. 24. Chromosomes in early telophase II, showing the major spirals drawn out in places.  $\times 1300$ .

shown in Fig. 12 (see the chromosome indicated by an arrow). When the stage proceeds to the telophase, the spirals become generally, considerably drawn out, and the major spirals are no longer detectable in those chromosomes which reach the poles. Fig. 13 is a reproduction of the chromosomes in the early telophase II. In these chromosomes, the major spirals are almost completely drawn out so as to present in places only the undulating aspects as their remains, and the minor spirals only are conspicuous. When the chromosomes reach the poles, they become contracted in length, and finally the nucleus with the reticulate appearance is formed.

### Conclusion

In this plant, there are found, according to the environmental conditions, two types of the chromosome structure in the second metaphase in respect of the mode of coiling of the spirals. In one type which is found in the material from pot plants, the spirals are single-coiled, and in the other which is observed in the material collected in the field, they are double-coiled. Many intermediate forms are also found in the materials of both origins. TAYLOR (1931) and TUAN (1931) have observed these two types of chromosome structure, namely the spirals of the type of major gyres and those of the type of minor gyres, in the homotype metaphase in *Gasteria*. In certain species of *Lilium*, KATO and IWATA (1935) have also observed the same two types to exist in the second metaphase, and have interpreted this variation in the mode of coiling as responsible to the behaviour of the chromosome matrix. In his observation of *Trillium*, IWATA (1940 a) has observed the same variation also in the interkinesis. The author has expressed the view that under different environmental conditions the behaviour of the chromonemata may be different. This view is supported by the facts observed in *Lilium japonicum* in the present investigation, that according to whether the plants grow in the field or in pots, the mode of coiling of the spirals in the second division is different.

### Summary

- 1) In fixed preparations, the chromatic spirals in the first metaphase appear to be single-coiled and single-stranded major spirals. In acetocarmine preparations, however, it is revealed that they are in reality double-coiled spirals with the major and minor spirals.
- 2) In the telophase I, the major spirals are considerably drawn out.
- 3) In the material from the plants growing in the field the major spirals are drawn out to a considerable extent in the interkinesis, though the spirality is in places still perceptible with a certain distinctness.

4) In the material collected from the plants transplanted in pots from the field in the preceding summer, the major spirals are drawn out in interkinesis completely into the single-coiled spirals of minor gyres.

5) In acetocarmine preparations, the nucleus in interkinesis shows a complicated structure which may appear to be a reticulate structure, whereas in the case of fixed material the spirality of the chromatic threads is perceptible more or less clearly in the nucleus of this stage.

6) In the material from the field, the major spirals reappear in the second prophase to cause the chromosomes to be of the double-coiled structure.

7) The chromosomes from the pot material are, on the other hand, of the single-coiled structure.

8) In the fixed material, the minor spirals are observable only in the part in which the spirals are considerably drawn out.

9) In the second telophase the chromosomes are usually observed conspicuously drawn out in the proximal region.

In conclusion the writer wishes to express his sincere thanks to Prof. Y. KUWADA for his suggestions and criticisms throughout the course of the investigation.

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### Explanation of plate XIII

All the figures are microphotographs taken from acetocarmine preparations using ZEISS' homog. imm. 1/12 and comp. oc. 15 $\times$ .

- Fig. 1. Chromosomes in metaphase I showing the major spirals.
- Fig. 2. Chromosomes in the anaphase I showing the major spirals.
- Fig. 3. The same showing the major spiral drawn out in the proximal region.
- Fig. 4. Nucleus in the telophase I.
- Fig. 5. Nucleus in interkinesis showing a "reticulate" structure.
- Fig. 6. The same showing the minor spiral structure of chromosomes.
- Figs. 7 and 8. Nuclei in homotype prophase showing the spirals of major gyres.
- Fig. 9. Homotype metaphase showing the major spirals.
- Fig. 10. The same showing the minor spiral (single-coiled) structure of chromosomes.
- Fig. 11. The same showing the tertiary split.
- Fig. 12. Chromosomes in anaphase II showing the double-coiled structure.
- Fig. 13. Telophase II showing the chromosomes completely drawn out from their major spirals.
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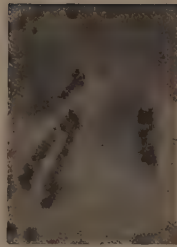
PLATE XIII



1



2



3



4



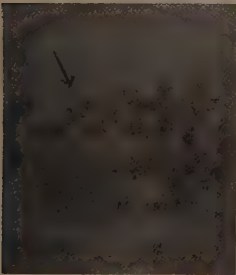
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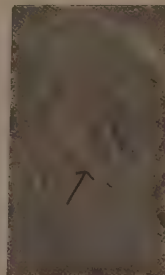
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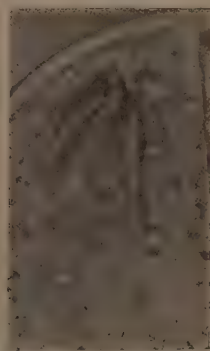
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13



## Cytogenetical studies on *Oryza sativa* L.

### V. The cytogenetics of $F_1$ hybrid of *O. sativa* L. and *O. latifolia* DESV.

By Toshitaro MORINAGA

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With 37 text-figures and 3 tables

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(Received August 12, 1941)

*O. sativa* L. and *O. latifolia* DESV. belong to the same section of *Oryza*, namely Section *Sativa* ROSCHEV. According to ROSCHEVICZ (7), however, *O. latifolia* DESV. occurs in Central and South America only, and the wild form of *O. sativa* L. is found in India, Indo-China, Australia and Africa, but not in Central and South America. On the basis of botanic-geographical studies, *O. latifolia* Desv., though fairly resembling *O. sativa* L., has not been regarded as a progenitor of any varieties of cultivated rice (7). The chromosome number of *O. latifolia* DESV. was made known, in 1933, by GOTOH and OKURA (1) as  $2n = 48$ , or twice as many as *O. sativa* L. has. Since 1935, the present author has been engaged in cytogenetical investigations on the interspecific hybrid of *sativa* and *latifolia* as a part of his *Oryza* studies. The results of the cytological investigations were reported briefly in 1937 (3), and the results on the side of breeding were given out in the following year (4). In the present paper they will be presented in a rather complete form with some addition of new results.

#### RESULTS OF BREEDING EXPERIMENTS

##### Materials and methods

*O. latifolia* DESV.,  $2n=48$ . This species was kindly provided, in 1934, by Dr. I. SUZUTA of the Taihoku Imperial University. The species is, as compared with common varieties of *O. sativa* L., much greater in height, having procumbent stems with coarse and wide leaves. The panicles are of a spreading type and produce small and strongly deciduous spikelets. The short ligules with fringed hairs also make another striking contrast (Fig. 1).



*O. sativa* L.,  $2n = 24$ . Fifteen cultivated varieties from various parts of the world were chosen for the cross experiments. Of these varieties, 7 were of Japan proper (3 normal varieties and 4 abnormal mutant types) and 4 were of China. Four other varieties came from Africa, South America, Java and U.S.S.R. (Fig. 2).

Artificial hybridization was performed in the same way as in the case of his other cross experiments of *Oryza*.

### Results of crossing

In 1935, artificial hybridization was tried reciprocally between *O. sativa* L. and *O. latifolia* DESV. Taking *latifolia* on the maternal side, one Japanese and three foreign varieties were mated. The number of flowers pollinated was in total 243, and none of those produced any true seeds. The ovaries developed more or less in 23 spikelets, but they were nothing but parthenocarpic. On the other hand, 13 varieties of *sativa* were chosen on the maternal side, and 1736 flowers altogether were pollinated with the pollen-grains of *latifolia*. Forty spikelets (2.3%) produced perfect or nearly perfect grains, and 577 (33.24%) produced grains ill developed to various degrees. In 272 spikelets (15.67%) parthenocarpic development of ovaries was noticed. The classification of grains, perfect, ill developed, and parthenocarpic, was of somewhat arbitrary nature. In 1936, all grains above mentioned were put on a germination bed in Petri-dishes obtaining 391 seedlings, of which 120 perished soon after germination. Out of those 271 plants that grew up into adult, 27 were exactly the same as their mother plants, suggesting the occurrence of unexpected pollen contamination. The true  $F_1$  plants which reached maturity were 244 in number, that is 14% of the total number of flowers artificially pollinated. The *sativa* varieties which produced true hybrids with *latifolia* were, Iyogasuri No. 1 (7  $F_1$  plants), Zuihō (13  $F_1$  plants), Nisitaku-moti (67  $F_1$  plants), Tyōkokusyu (10  $F_1$  plants), Risizinkoku (38  $F_1$  plants) and Russian No. 65 (109  $F_1$  plants). All the  $F_1$  plants were uniform in appearance for each parental combination. One representative plant of each was preserved for later investigations at the end of that season.

From the cross experiments above mentioned (cf. Table I), it is concluded that the interspecific hybrid is more easily obtainable when the species *sativa* is taken on the female side. The reciprocal crosses between *latifolia* and Tyōkokusyu and Risizinkoku well serve to demonstrate the fact. The success of hybridization also depends on the varieties of *sativa* chosen to mate.

TABLE I. Results of artificial cross pollination between *O. sativa* L. and *O. latifolia* DESV., in 1935.

Line No. of F <sub>1</sub> in 1936	Combination of parents		Number of flowers pollinated		Number of perfect grains obtained		Number of imperfect grains obtained		Number of partheno- carpic ovaries		Number of sterile spikelets		Number of grains germinated		Number of seedlings died soon after germination		Number of selfed individuals		Number of true F <sub>1</sub> plants survived	
82	<i>latifolia</i> ×	*Kinen-moti	67	0	0	0	14	53	0	0	0	0	0	0	0	0	0	0	0	0
83	„ ×	African akakawa	16	0	0	0	2	14	0	0	0	0	0	0	0	0	0	0	0	0
84	„ ×	Tyokokusyu	124	0	0	0	7	117	0	0	0	0	0	0	0	0	0	0	0	0
—	„ ×	Risizinkoku	36	0	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0
	Total		243	0	0	0	23	220	0	0	0	0	0	0	0	0	0	0	0	0
85	*Kogane-nisiki	× <i>latifolia</i>	24	0	0	0	7	17	1	1	0	0	0	0	0	0	0	0	0	0
86-87	*Kisinriki	× „	77	1	3	34	39	2	0	2	0	2	0	2	0	2	0	0	0	0
88-89	*Iyogasuri No. 1	× „	107	0	9	29	69	8	1	0	7									
90	*Modori-moti-kawari	× „	24	0	0	0	7	14	0	0	0	0	0	0	0	0	0	0	0	0
91, 92, 116	*Zuihō	× „	196	8	47	9	132	25	6	6	13									
93-102	*Nisitaku-moti	× „	618	6	214	110	288	112	41	4	67									
103-105	Waito-koto	× „	131	16	3	11	101	14	14	0	0									
106	Kōkansen	× „	22	0	0	2	20	0	0	0	0									
107	Tyokokusyu	× „	47	0	18	2	27	15	5	0	10									
108	Risizinkoku	× „	69	0	49	0	20	40	2	0	38									
109	Amarelia	× „	31	0	0	21	10	0	0	0	0									
110-111	Java No. 11	× „	119	9	15	33	62	15	0	15	0									
112-115	Russian No. 65	× „	271	0	219	7	45	159	50	0	109									
	Total		1736	40	577	272	847	391	120	27	244									

Note: \*Japanese varieties, the others being foreign.

Description of F<sub>1</sub> plants

Nine F<sub>1</sub> individuals, one of Iyogasuri × *latifolia* and two of each Zuihō × *latifolia*, Nisitaku-moti × *latifolia*, Risizinkoku × *latifolia* and Russian No. 65 × *latifolia*, were kept from August 6th under the controlled day length of 8 hours, the remaining F<sub>1</sub> plants being left under natural condition. Under the natural day length, the F<sub>1</sub> plants, though conceived the ear at the end of October, could not shoot after all. On the 10th of November some representatives of those were brought into a greenhouse, where they shot the ear in about 10 days. The F<sub>1</sub> plants kept under the short day condition were in the ear early in September.

Although the contrasting characters of the parental species and their phenotypic manifestations in each kind of  $F_1$  plants are represented in Table II and III, some descriptions may be added here in a more general way.

TABLE II-a. Parental contrasting characters and their  $F_1$  manifestation.

Characters		<i>O. latifolia</i>	Iyogasuri No. 1	Zuihō	Nisitaku-moti	Russian No. 65	Tyokoku-syu	Risizin-koku
Awn	length	long			very short			
	density	dense	awnless	awnless	very rarely	awnless	awnless	awnless
	colour	green			light purple			
Spikelet	size	small	large	large	large	large	large	large
	tip-colour	colourless	colourless	colourless	light purple	colourless	colourless	colourless
	flower glume-colour	green	green	green	green	green	green	green
	empty glume-colour	colourless	colourless	colourless	colourless	colourless	colourless	colourless
	deciduousness	deciduous	not deciduous	not deciduous	not deciduous	not deciduous	not deciduous	not deciduous
Stigma	habit of exposure	exposed	normal	normal	normal	normal	normal	normal
	colour	purple	white	white	white	white	white	white
Anther-colour		yellowish brown	light yellow	light yellow	light yellow	light yellow	light yellow	light yellow
Leaf	shape of ligules	short, not acute	long, acute	long, acute	long, acute	long, acute	long, acute	long, acute
	ligule-colour	colourless	colourless	colourless	colourless	colourless	colourless	colourless
	terminal leaf-blade-length	short	long	long	long	long	long	long
	terminal leaf-blade-width	wide	narrow	narrow	narrow	narrow	narrow	narrow
	leaf-blade-colour	green	green with white spots	green	green	green	green	green
	junction-colour	colourless	colourless	colourless	colourless	colourless	colourless	colourless
	leaf-sheath-colour	purple streak	green	green	green	green	green	green
Stem	thickness	thick	thick	thick	thick	thick	thick	thick
	internode-colour	green	green	green	green	green	green	green
	node-colour	colourless	colourless	colourless	colourless	colourless	colourless	colourless
Habit		procumbent	erect	erect	erect	erect	erect	erect
Plant height		high	low	low	low	low	high	high
Panicle habit		spreading	closed	closed	closed	closed	closed	closed
Panicle length		long	short	short	short	long	long	short

TABLE II-b. Parental contrasting characters and their F<sub>1</sub> manifestation.

Characters		Iyogasuri No. 1 × <i>O. latifolia</i>	Zuihō × <i>O. latifolia</i>	Nisitaku- moti × <i>O. latifolia</i>	Russian No. 65 × <i>O. latifolia</i>	Tyokoku- syu × <i>O. latifolia</i>	Risizin- koku × <i>O. latifolia</i>
Awn	length	long	long	long	long	long	long
	density	dense	dense	dense	dense	dense	dense
	colour	purple	purple	purple	purple	—	purple
Spikelet	size	inter- mediate	inter- mediate	inter- mediate	inter- mediate	inter- mediate	inter- mediate
	tip-colour	purple	purple	purple	purple	—	purple
	flower glume-colour	green	green	green	green	—	purple
	empty glume-colour	—	purple	purple	colourless	—	purple
	deciduousness	deciduous	deciduous	deciduous	deciduous	deciduous	deciduous
Stigma	habit of ex- posure	—	—	—	exposed	—	exposed
	colour	purple	purple	purple	purple	purple	purple
Anther-colour		—	—	—	yellowish brown	—	yellowish brown
Leaf	shape of ligules	short (inter- mediate)	short (inter- mediate)	short (inter- mediate)	short (inter- mediate)	short (inter- mediate)	short (inter- mediate)
	ligule-colour	colourless	colourless	colourless	colourless	colourless	colourless
	terminal leaf-blade-length	short	short	short	short	short	short
	terminal leaf-blade-width	wide	wide	wide	wide	wide	wide
	leaf-blade-colour	green	green	purple vein	green	purple vein	purple vein
	junction-colour	—	colourless	colourless	colourless	colourless	colourless
	leaf-sheath- colour	—	green	purple streak	purple streak	purple streak	purple streak
Stem	thickness	thick	thick	thick	thick	thick	thick
	internode-colour	—	purple	purple	green	—	purple
	node-colour	—	colourless	colourless	colourless	—	colourless
Habit		semi-pro- cumbent	semi-pro- cumbent	semi-pro- cumbent	semi-pro- cumbent	semi-pro- cumbent	semi-pro- cumbent
Plant height		high	low	high	high	high	high
Panicle habit		spreading	spreading	spreading	spreading	spreading	spreading
Panicle length		short	short	short	short	long	long

As already mentioned, *O. latifolia* is characterized by its procumbent growth habit, and its tall and thick culms with coarse and wide leaf-blade, the short terminal leaf-blades also being characteristic. The hybrids are



semi-procumbent with leaves of intermediate coarseness, the terminal leaf-blade being short and wide. *O. latifolia* also differs from *O. sativa* in its large auricles and short ligules with a fringe of hairs. The auricles of the hybrids are large, and the ligules are short with some hairs on the apex. The spreading panicles, producing markedly small and highly deciduous spikelets with moderately long awns, make another characteristic of *latifolia*. The ears of the hybrids are of spreading type, the spikelets being small and deciduous. The hybrid spikelets produce very

TABLE III. Some measurements on parents and hybrids, in 1936.

	Height of plant cm.	Length of culm cm.	Length of panicle cm.	Thickness of culm mm.	Terminal leaf-blade		Length of spikelet mm.	Width of spikelet mm.	Length of awn mm.
					Length cm.	Width cm.			
<i>O. latifolia</i>	115.0	91.2	23.8	3.2	18.2	2.0	5.7	2.0	11.4
Iyogasuri No. 1	96.6	77.9	18.7	3.2	24.5	1.3	7.1	3.5	0
Zuihō	—	—	20.4	—	—	—	7.4	3.5	0
Nisitaku-moti	101.3	78.5	22.7	3.6	34.4	1.2	7.6	3.0	0
Russian No. 65	107.4	84.0	23.4	3.5	26.6	1.5	7.5	3.6	0
Tyokokusyu	131.1	106.9	24.2	4.0	26.9	1.5	7.5	3.3	0
Risizinkoku	119.5	97.0	22.5	3.6	25.9	1.3	8.1	3.5	0
Iyogasuri No. 1×1.	117.2	94.9	22.2	4.3	17.2	2.0	6.3	2.2	44.4
Zuihō×1.	107.3	87.8	19.5	3.8	16.3	1.9	6.3	2.0	41.6
Nisitaku-moti×1.	121.9	100.5	21.3	4.0	17.3	1.9	6.3	2.1	40.3
Russian No. 65×1.	124.3	102.8	21.5	3.9	14.2	1.7	6.5	2.4	45.4
Tyokokusyu×1.	147.9	121.0	26.9	4.5	17.6	2.2	6.4	2.3	48.0
Risizinkoku×1.	156.0	129.1	26.9	4.9	16.8	2.2	6.4	2.4	41.2

long awns, though the varieties of *sativa* mated are either perfectly awnless or are nearly so. The anthers of *latifolia* are yellowish brown, and its purple stigmas expose themselves fully out of the flowering glumes, contrasting with the light yellow anthers and enclosed stigmas of *sativa*. In the hybrids, such flower organs do not develop in full measure, especially in the hybrids with Japanese varieties. The anthers of the hybrids with foreign varieties are yellowish brown, and the stigmas, purple in colour, are exposed out of the glumes. In the experiments, quoted in Table II and III, the height of *latifolia* was much reduced owing chiefly to the conditions of cultivation (Figs. 1-5).



Fig. 1.



Fig. 2.



Fig. 3.



Fig. 4.

Fig. 1. *O. latifolia* DESV.

Fig. 2. *O. sativa* L. (Zuihō).

Fig. 3. F<sub>1</sub>-103, Risizinkoku × *O. latifolia*.

Fig. 4. F<sub>1</sub>-89, Iyogasuri No. 1 × *O. latifolia*.

### Fertility of $F_1$ plants

The fertility of the hybrids is very low even by open pollination. In 1936, the fertility was examined on the materials subjected to the short day treatment. Taking all well developed panicles, 335, 1251, 1355, 2100 and 1496 spikelets were examined respectively for *Iyogasuri*  $\times$  *latifolia*, *Zuihō*  $\times$  *latifolia*, *Nisitaku-moti*  $\times$  *latifolia*, *Risizinkoku*  $\times$  *latifolia*, and Russian No. 65  $\times$  *latifolia*. All spikelets of the first three hybrids were

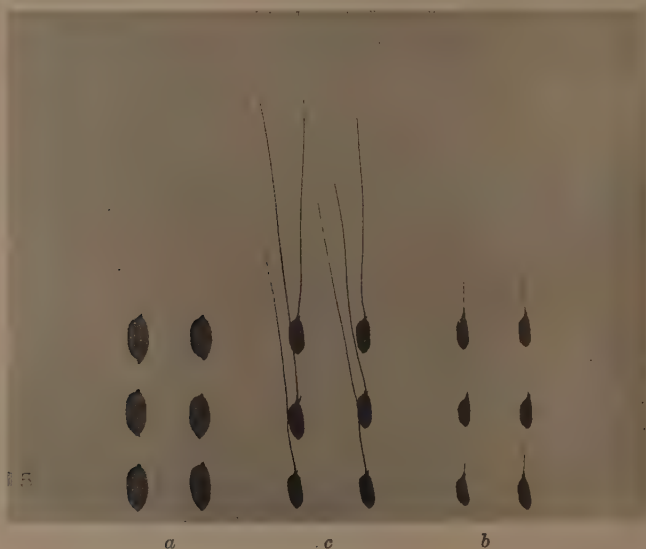


Fig. 5.

Fig. 5. Comparison of the spikelets. a. Russian No. 65; b. *O. latifolia*; c.  $F_1$ -115.

proved to be sterile, while 50 grains (47 perfect and 3 imperfect) were obtained from *Risizinkoku*  $\times$  *latifolia*, and 23 grains (21 perfect and 2 imperfect) from Russian No. 65  $\times$  *latifolia*. Thus the fertility was calculated to be 2.38 and 1.54% respectively for those two kinds of hybrid. No individuals of *Tyōkokusyu*  $\times$  *latifolia* were treated by the short day method, and the fertility of that hybrid was not investigated. The fertility was still lower in 1937. Four individuals of each kind of hybrids, excepting *Iyogasuri*  $\times$  *latifolia* of which 3 individuals, were subjected to the short day treatment to investigate the fertility. One seed was obtained from *Tyōkokusyu*  $\times$  *latifolia* and none of other hybrids produced any seeds, though the spikelets examined amounted to several thousands for each hybrid.

## F<sub>2</sub> plants

In 1937, three F<sub>2</sub> plants of the hybrid, Risizinkoku  $\times$  *latifolia*, were raised. Twenty eight seeds of Ind. No. 1 and 14 seeds of In. No. 2 were sown, and 8 and 4 seeds germinated respectively. The seedlings which grew up to adult, however, were only 1 (F<sub>2</sub>-10) for the first group and 2 (F<sub>2</sub>-11-1 and F<sub>2</sub>-11-2) for the second. The 3 F<sub>2</sub> plants differed one another in various morphological characters, though their shooting time under the short day condition was nearly the same. The fertility of the F<sub>2</sub> plants was very low. The plants, F<sub>2</sub>-10 and F<sub>2</sub>-11-2, produced 761 and 619 spikelets all in vain, and out of 722 spikelets produced by the plant, F<sub>2</sub>-11-1, 3 grains were obtained.

## Cytological observations

The microsporogenesis was studied chiefly on the materials fixed in 1936 and 1937. The somatic chromosomes were observed exclusively in the root-tip cells. The kinds of the fixing solutions and other methods used were the same as those adopted by the author in his other *Oryza* investigations (2).

### Observation on somatic chromosomes

The gametic number of chromosomes is 12 for all *sativa* varieties used, and the gametic number for *latifolia* is 24. All the F<sub>1</sub> plants examined possesses 36 somatic chromosomes (Fig. 6).



Fig. 6.

Fig. 6. Somatic chromosomes in the root-tip cell.  
a. *O. latifolia*; b. Tyokokusyu  $\times$  *O. latifolia*.  $\times 2670$ .

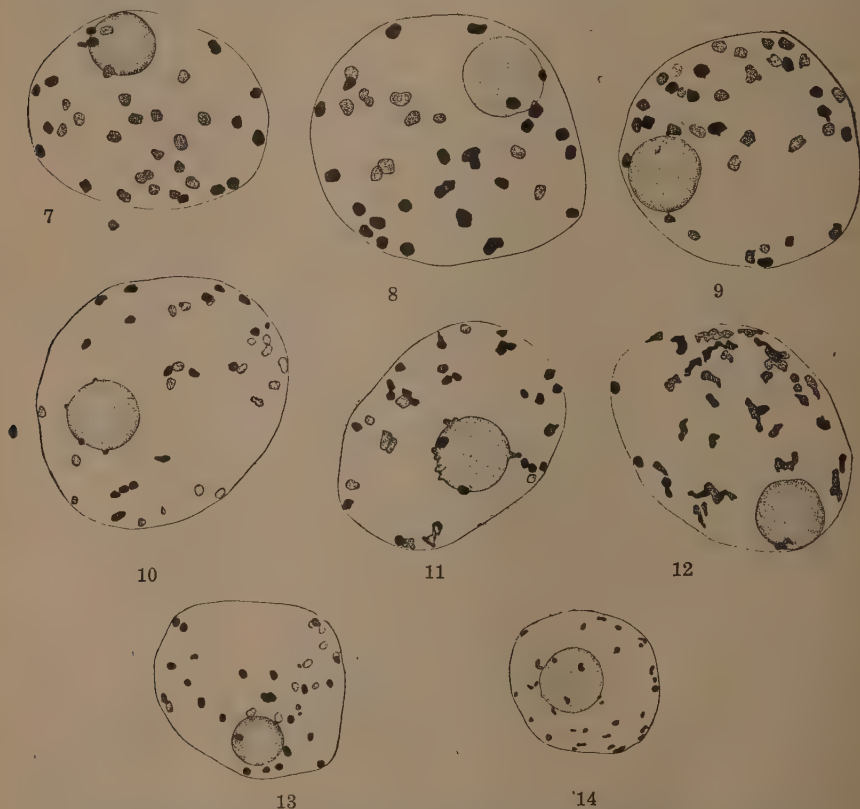
### Observation on microsporogenesis

Owing to degeneration of archesporial cells, also to their irregular nuclear and cell divisions, pollen-mother-cells of normal appearances were met with rather rarely. Most of the pollen-mother-cells again



degenerated in their early meiotic stages. Following observations were made on those four kinds of hybrids, namely, *Zuihō*×*latifolia*, *Nisitakumoti*×*latifolia*, *Tyôkoku*×*latifolia* and *Risizinkoku*×*latifolia*.

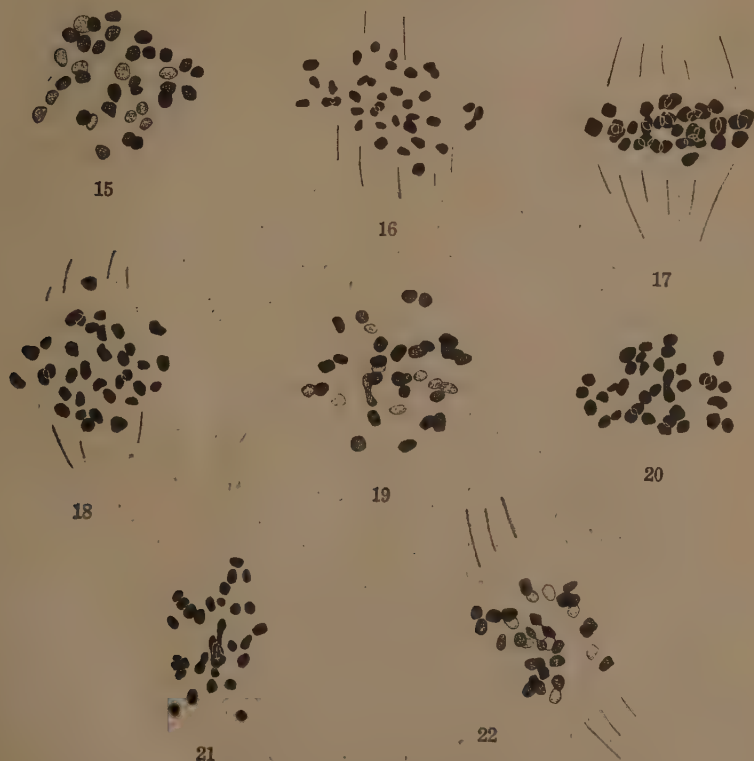
*Heterotypic division*: The normal nucleus in syndesis contained a synaptic ball of fine threads and one large nucleolus often with one or two small buds. Two large nucleoli contacting together were also found.



Figs. 7-14. Diakinetic nuclei of the *F*<sub>1</sub> hybrid, *O. sativa*×*O. latifolia*. Figs. 7-12 (*Zuihō*×*latifolia*), giant nuclei of common occurrence. Figs. 13 and 14 (*Nisitakumoti*×*latifolia*), nuclei of regular size. ×1600. Figs. 7-10 and 12 contain no clear bivalents. Fig. 11 shows 2 or 3 bivalents and 4 groups of 2 chromosomes. In Fig. 13, 1 bivalent is clearly noticed.

In some nuclei, many chromatic granules appeared conspicuously in the synaptic ball, while in others, the nucleolus was found in the center of diffused chromatic substance. The nucleus in diakinesis usually took a magnificently large size, the nucleolus and the chromosomes included being

large in that proportion (Figs. 7-12). Retardation of the division processes might be responsible for such excessive growth. The nuclei of normal size, such as depicted in Figs. 13 and 14, were of very rare occurrence. Both kinds of diakinetid nuclei, large and small, contained about 36 chromosomes. To know the degree of bivalent formation of chromosomes, the author examined carefully more than forty nuclei. Some



Figs. 15-22. Side and polar views of the heterotypic metaphase of the hybrid, *O. sativa* × *O. latifolia*. Figs. 15, 17, 19, 20 and 22 from Zuihō × *latifolia*, and Figs. 16, 18 and 21 from Nisitaku-motii × *latifolia*. × 2670. Figs. 15-18 show no bivalents. Figs. 19 and 20 contain 1 bivalent for each. Fig. 22 shows 2 bivalents, while more than 2 bivalents are counted in Fig. 21.

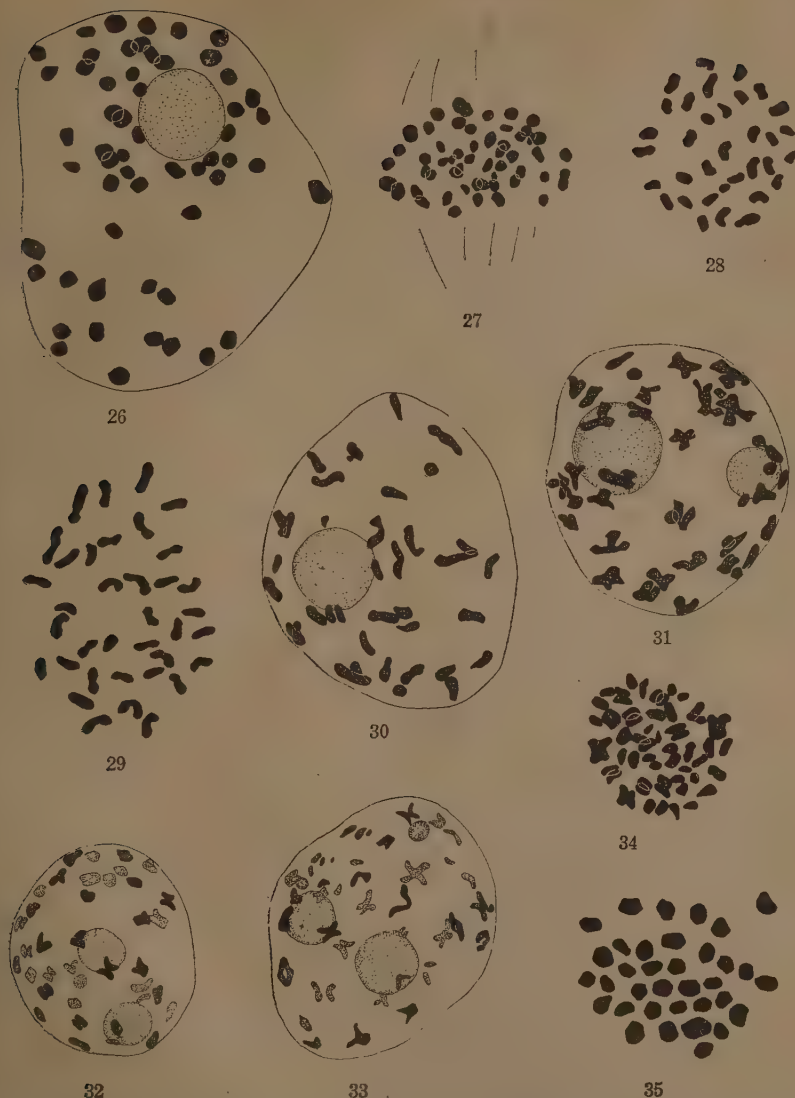
representatives of those are shown in Figs. 7-14. Figs. 7-10, and Fig. 12 contain, like the majority of the nuclei examined, no clear bivalents, while in Fig. 13 one bivalent is noticed distinctly. The nucleus in Fig. 11 seems to have two or three bivalents together with four groups of two chromo-

somes which may or may not be true association. Pollen-mother-cells in heterotypic metaphase were found less frequently than those in diakinesis. They had also about thirty six chromosomes (Figs. 15-22).



Fig. 23. The heterotypic metaphase in an embryo-sac mother-cell of *Tyokokusyu*  $\times$  *latifolia*.  $\times 2670$ .

Figs. 24 and 25. The heterotypic anaphase of the hybrid, *Nisitaku-motix*  $\times$  *latifolia*.  $\times 2670$ .



Figs. 26-35. Abnormal archesporial or pollen-mother-cells of the hybrid, *O. sativa*  $\times$  *O. latifolia*. Figs. 26-28, 31 and 35, from Zuihō  $\times$  *latifolia*. Figs. 29 and 34 from Tyokokusyu  $\times$  *latifolia*. Figs. 30, 32 and 33 from Risizinkoku  $\times$  *latifolia*.  $\times 2670$ . Figs. 26 and 27. Nuclei with about 55 chromosomes. Figs. 28-30. Two metaphasic and one prophasic nuclei with 36 somatic type chromosomes. Figs. 31-33. Somatic diakinesis. Fig. 34. Metaphasic plate with bivalents and univalents. Fig. 35. Metaphasic plate with 34 bivalents and 1 tetravalent.



Figs. 15-18 show no bivalents, while Figs. 19 and 20 contain one bivalent for each. Two bivalents are clearly noticed in Fig. 22, and more than two bivalents may be counted in Fig. 21. The heterotypic metaphase in an embryo-sac mother-cell, which is depicted in Fig. 23, contains two bivalents. Thus bivalent chromosomes, though occurred occasionally in the present hybrids, are very limited in number. The pollen-mother-cells in heterotypic anaphase were observed still less frequently, but it might be safely said that the univalents in the equator divide slowly, the rest of those being distributed directly to the nearer pole (Figs. 24 and 25).

*Homotypic division:* For all his efforts, the author could not find out any figures assumed as the homotypic division. In these hybrids, pollen-mother-cells outliving the heterotypic division must be very rare.

*Irregularities:* In addition to the pollen-mother-cells as above described, cells and nuclei of entirely different types were also found. The details of the latter are given as under.



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Fig. 36. A giant abnormal pollen-mother-cell found in *Nisitaku-motixlatifolia*.  $\times 1600$ .

1. Figs. 29 and 30 show one type of abnormalities. The nucleus in the latter figure, though looking like in diakinesis, contains thirty six rod-shaped chromosomes. The metaphasic chromosomes in Fig. 29 are also of somatic type. These nuclei neither belong to the normal type of archesporial cells, nor to that of pollen-mother-cells. The thirty six

metaphasic chromosomes shown in Fig. 28 are much shortened, but they are also hardly assumed as the heterotypic chromosomes. A modified type of somatic nuclear division seems to take, sometimes, the place of the regular heterotypic division.

2. Figs. 26, 27 and Figs. 31-35 show another type of abnormalities occurring not infrequently. The characteristics of this type is, above all,

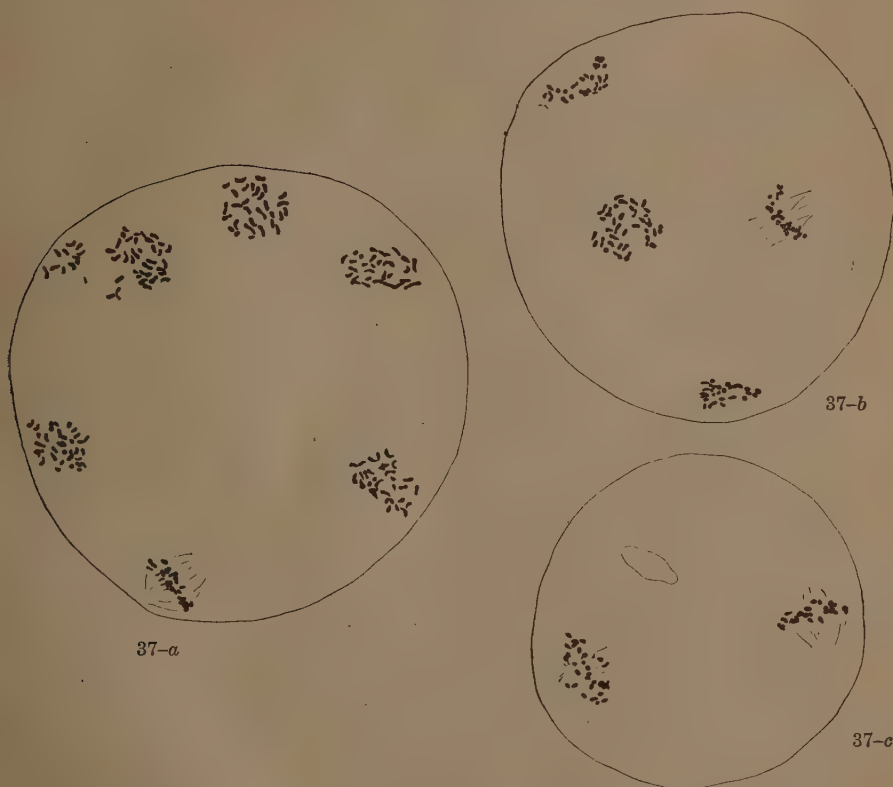


Fig. 37. A giant abnormal archesporial cell found in *Tyokokusyu*  $\times$  *latifolia*.  
 $\times 1330$ . A cell in 3 sections.

in its large chromosome number. The diakinesis like nuclei in Figs. 31-33 have two large and one or two small nucléoli, and about forty chromosomes mostly bivalent. These figures and Fig. 34 remind the author of so called somatic diakinesis often found in tumour and other somatic tissues producing occasional tetraploid cells. The nuclei in Figs. 26 and 27, though look like normal, contain more or less fifty five chromosomes. In

Fig. 35 one tetravalent and thirty four bivalent-like metaphasic chromosomes are counted. Somatic chromosomal doubling, complete or partial, no doubt, occurs in some archesporial cells with reduced ability of division.

3. Giant cells with supernumerary nuclei belong to the third type. One remarkable example of this type is presented in Fig. 37. This cell contains 14 scattered nuclei which are going to divide simultaneously.

### Conclusion

In the fourth report of this series, the author has described on the hybrid, *O. sativa* L.  $\times$  *O. minuta* PRESL. (6). In the present experiments, *O. latifolia* DESV. was mated with *O. sativa* L. Comparing with *O. minuta*, *O. latifolia* is generally assumed as a remoter relative of *O. sativa*. Notwithstanding such phylogenic interrelations, the cross ability was clearly higher in the latter matings. As described above, 15.2% of the *sativa* flowers pollinated with the pollen of *latifolia* produced germinable  $F_1$  seeds, the corresponding percentage with the pollen of *minuta* being only 1.1%. Moreover, the percentage of the  $F_1$  plants perished in the seedling stage was much higher for the hybrid, *O. sativa*  $\times$  *O. minuta*. On the other hand, *O. latifolia* was crossed successfully to both Japanese and foreign varieties of *O. sativa*, but the efforts to mate *O. minuta* with foreign varieties of *O. sativa* were apparently unavailing.

The fertility was very low for both hybrids, *O. sativa*  $\times$  *O. minuta* and *O. sativa*  $\times$  *O. latifolia*, but in certain cases it was clearly higher in the hybrid of foreign varieties of *O. sativa* and *O. latifolia*. These results of breeding experiments do not agree with the simple expectations from the presumed phylogenic interrelations of those three species. The results, however, disclose here and there the intraspecific differentiations of *O. sativa*.

In the hybrid, *O. sativa*  $\times$  *O. latifolia*, archesporial and pollen-mother-cells degenerate more badly than in *O. sativa*  $\times$  *O. minuta*. Excessive growth of the diakinetik nuclei in *O. sativa*  $\times$  *O. latifolia* may be taken as the first step of degeneration. Keeping pace with degeneration, irregular archesporial or pollen-mother-cells of various kinds are produced in a high frequency. These facts seems to suggest that the cytological condition in *O. sativa*  $\times$  *O. latifolia* is in less harmony than the condition in *O. sativa*  $\times$  *O. minuta*.

The present experiments also demonstrate that the *sativa* set chromosomes fail to pair in meiosis with the chromosomes of *latifolia*. A few bivalent chromosomes occasionally met with may be reasonably accounted as the results of autosyndesis. Like the chromosome complex of *O. minuta*, the complex of *O. latifolia* is also composed of two dissimilar chromosomal sets with twelve componental chromosomes respectively (5). Now on

the basis of the affinity of chromosomes in the  $F_1$  hybrid, it is concluded that neither one of the two chromosomal sets of *O. latifolia* is homologous to the set of *O. sativa*. The hypothesis that *O. sativa* L. and *O. latifolia* DESV. take remote position each other in phylogeny, is well corroborated by those cytogenetical investigations. The genomic relation of *O. minuta* and *O. latifolia* will be discussed in the following publication of this series.

### Summary

1. Since 1935, the author has been engaged in cytogenetical studies of the interspecific hybrid, *O. sativa*  $\times$  *O. latifolia*. The results hitherto obtained are presented in this paper.
2. The hybridization between *O. sativa* and *O. latifolia* was successful only when the former species was taken as the maternal parent. With 13 varieties of *sativa*, 1736 flowers were pollinated artificially with the pollen of *latifolia*, and they produced 264 germinable  $F_1$  seeds. No difference in crossability was noticed between Japanese and foreign varieties of *sativa*.
3. The  $F_1$  hybrid resembled *O. latifolia* more closely in some characters than it did *O. sativa*, in other characters resembling *O. sativa* more closely, or being intermediate of the parents. The awn length of the hybrids far exceeded the awn length of *latifolia*, regardless of the awnless character of *sativa* mated with.
4. The  $F_1$  hybrids were highly sterile, and only three  $F_2$  plants were raised. The  $F_2$  plants, differing one another in various morphological characters, also showed high sterilities.
5. Degeneration of archesporial and pollen-mother-cells occurred badly. In diakinesis, the nucleus assumed a very large size, and no pollen-mother-cells in the homotypic division were found. Irregular cells and nuclei of various types were met with. Among others, types of nuclei with increased number of chromosomes called special attention.
6. In the heterotypic division, no regular bivalent formation was noticed. Accounting occasional bivalent formation as autosyndesis, the author concludes that, the chromosome set of *O. sativa* L. is not homologous to either one of the two chromosome sets composing the chromosome complex of *O. latifolia* DESV.

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# ABSTRACTS

EXPLANATION OF ABBREVIATIONS OF THE JOURNALS' NAMES REFERRED  
IN THE ABSTRACTS OF VOL. XI, Nos. 1-545.

<i>Abbreviations</i>	<i>Names of Journals</i>
A.H.	Agriculture and Horticulture (農業及園藝)
A.P.	Acta Phytochimica
A.PP.S.J.	Annals of the Phytopathological Society of Japan (日本植物病理學會報)
A.PT.G.	Acta Phytotaxonomica et Geobotanica (植物分類地理)
A.S.	Agronomic Studies (農學研究)
B.I.S.E.S.T.	Bulletin of the Imperial Sericultural Experiment Station, Tokyo (東京蠶絲試驗場報告)
B.M.T.	The Botanical Magazine (Tôkyô) (植物學雜誌)
B.O.I.L.F.	Berichte des Ôhara Instituts für landwirtschaft- liche Forschungen
B.S.A.,T.I.U.	Bulletin of the School of Agriculture, Taihoku Imperial University (臺北帝國大學附屬農林專門部 學術報告)
B.S.,F.T.,K.I.U.	Bulteno Scienca de la Fakultato Terkultura, Kyû- syû Imperio Universitato (九州帝國大學農學部 學藝雜誌)
B.S.S.	Bulletin of Sericulture and Silk-Industry (蠶絲學 雜誌)
B.T.S.M.	Bulletin of the Tokyo Science Museum (東京科學博 物館研究報告)
B.Z.	Botany and Zoology (植物及動物)
Cyt.	Cytologia
E.R.	Ecological Review (生態學雜誌)
Jap.J.B.	Japanese Journal of Botany
J.Jap.B.	Journal of Japanese Botany (植物研究雜誌)
J.F.A.,H.I.U.	Journal of the Faculty of Agriculture, Hokkaido Imperial University
J.F.S.,H.I.U.	Journal of the Faculty of Science, Hokkaido Im- perial University
J.F.S.,I.U.T.	Journal of the Faculty of Science, Imperial Uni- versity, Tokyo
J.J.G.	Japanese Journal of Genetics (遺傳學雜誌)
J.S.,H.U.	Journal of Science, Hiroshima University

- J.S.T.A. Journal of the Society of Tropical Agriculture  
(熱帶農學會雜誌)
- M.C.A.,K.I.U. Memoirs of the College of Agriculture, Kyoto  
Imperial University
- M.C.S.,K.I.U. Memoirs of the College of Science, Kyoto Imperial  
University
- M.F.S.A.,T.I.U. Memoirs of the Faculty of Science and Agriculture,  
Taihoku Imperial University
- P.C.S.S.J. Proceedings of the Crop Science Society of Japan  
(日本作物學會紀事)
- P.I.A. Proceedings of the Imperial Academy
- P.J.S.A.P. Proceedings of the Japanese Society for the  
Advancement of Sciences (日本學術協會報告)
- R.B.,T.I.S.C. Research Bulletin of the Tokyo Imperial Sericul-  
tural College (東京高等蠶絲學校研究報告)
- Sc.P.,I.A.R.,F.S.,H.I.U. Science Papers, Institute of Algological Research,  
Faculty of Science, Hokkaido Imperial Uni-  
versity
- Sc.Rpts.,T.BR.D. Science Reports, Tokyo Bunrika Daigaku
- Sc.Rpts.,T.I.U. Science Reports, Tôhoku Imperial University
- Sc.S.S.I. Science of South Sea Islands (科學南洋)
- T.N.H.S.F. Transactions of the Natural History Society of  
Formosa (臺灣博物學會報)
- T.S.N.H.S. Transactions of the Sapporo Natural History  
Society (札幌博物學會報)
- T.T.S.A.S. Transactions of the Tottori Society of Agricultural  
Science (鳥取農學會報)

## Abstracts Nos. 430-545

(Referring to the principal papers on Botany and allied subjects which have appeared mostly during January-June 1941)

**430. Ueber die physiologischen Untersuchungen der Sporenkeimung bei Myxomyceten II. Der Einfluss des pH-Wertes der Lösungen auf die Sporenkeimung.** (Japanisch mit deutsch. Zfg.). Seiji ABE. (B.M.T. 55, 1941, 139-148, 5 Tabellen).

Die Sporenkeimung der Myxomyceten findet im destillierten Wasser am schnellsten statt, und zwar viel schneller als im Medium, wozu gewisse anorganische oder organische Säuren in schwachen Dosen hinzugefügt werden. Je saurer die Lösung ist, desto mehr verzögert sich die Keimung, und unter  $\text{pH}=4$  geschieht gar keine Keimung. In sehr verdünnter Pufferlösung unter  $\text{pH}=4$  können die Sporen zur Keimung kommen und die daraus angekommenen Schwärmer führen lebhaft Bewegungen aus, aber unter etwas  $\text{pH}=4$  sieht man gar kein solches Verhalten der Sporen. Wenn solche Sporen zum destillierten Wasser übergeführt werden, findet ihre Keimung statt, um die lebhaft bewegenden Schwärmer zu entlassen.

Nach den Resultaten der Verfs. Untersuchungen ist der optimale pH-Wert für die Sporenkeimung von *Fuligo septicum* var. *rufa* und *Reticularia Lycoperdon* 6,5, und für dieselbe von *Physarum gyrosom* 7,0.

Verf. machte eine wichtige Bemerkung betreffend die Bestimmung des pH-Wertes bei den auf die Sporenkeimung gerichteten Untersuchungen. Im Falle, nämlich, wo die Sporenkeimung von solchen Myxomyceten, deren Sporangienwand kalkhaltig ist, wie bei *Badhamia*, *Physarum*, *Fuligo*, *Diachea*, etc., untersucht wird, muss man bestrebt sein, um sorgfältig die Verunreinigung des Mediums durch den Kalk aus der Sporangienwand zu vermeiden, weil sogar die Spuren des Kalkes mehr oder minder den pH-Wert stören können.

**431. Studies of mitosis and meiosis in comparison. II. Chromosome structure in the spiral stage and anaphase in mitosis as revealed by means of a maceration method.** Tosiya Aisima. (Cyt. 11, 1941, 429-435, 15 text-figs.).

In young root-tips of *Tradescantia reflexa* the chromosome structure in various stages of mitosis was studied by means of the maceration method with the mixture, 2 parts HCl+1 part 94% alcohol, which the author thinks most suitable in this case.

The author's summary of his experimental results runs as follows:

Each anaphase chromosome is composed of two chromatids, each of which contains a chromonema spiral or spirals. The two chromatids may twist around each other to a greater or less degree. During telophase and interphase the chromonema remains in the coiled state, although the coiling is rendered somewhat irregular. At the commencement of the prophase the chromonemata of each individual chromosome seem to draw close together. In the following stage the chromosome spirals are converted into regularly coiled major spirals in which the new minor coiling is in progress, as the result of which the prophasic chromosome changes, thus, for instance, the straightening out of the old spirals and the thickening and shortening of the chromosome, take place. Gradually each chromosome develops a visual longitudinal split.

**432. On the systematic anatomy of the leaves of some Japanese Carices XXXI-XXXIV.** (Japanese with English résumé). Shigeo AKIYAMA. (B.M.T. 55, 1941, 79-85, 124-130, 176-180, 213-217, altogether 16 text-figs.).



*Carex Maximowiczii* MIQUEL, *C. incisa* BOOTT, *C. descendens* KÜKENTHAL, *C. dimorpholepis* STEUDEL, *C. Middendorffii* FR. SCHMIDT, *C. Lyngbyei* HORNEM., *C. ketonensis* AKIY., *C. papulosa* BOOTT, *C. livida* WILLD., *C. limosa* L., *C. rariflora* SMITH, *C. vaginata* var. *Petersii* AKIY., *C. laxa* WAHL. are studied in respect to the anatomical structure of their leaves. Two analytical keys for the determination of certain species of *Carex* on the basis of their anatomical characters are given.

**433. Lichenologische Notizen (XV)–(XVI).** (Japanisch und deutsch mit lateinischen Diagnosen). Yasuhiko ASAHINA. (J. Jap. B. **17**, 1941, 71–76, 5 Textfig.; 136–143, 4 Textfig.).

Die folgenden Flechten sind erwähnt: *Parmelia neglecta* ASAHINA sp. nov., *P. simodensis* ASAHINA, sp. nov. (Nachweis der d-Protolichesterinsäure in der letzteren Art von FUZIKAWA bearbeitet), *P. manshurica* ASAHINA sp. nov., *Cladonia chondrotypa* WAIN., *Ramalina Sekika* ASAHINA sp. nov., *R. pseudosekika* ASAHINA sp. nov., *Lopadium shikokianum* ASAHINA sp. nov.).

**434. Ueber den enzymatischen Abbau der Alginsäure.** (Japanisch m. deutsch. Zfg.). Shozo ENDO. (B.M.T. **55**, 1941, 41–49).

Die Zusammenfassung der im obigen Titel genannten Arbeit steht wie folgt (nach den eigenen Worten d. Verfs.):

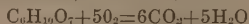
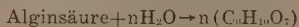
1. Die Wirkung von Alginase aus Molluskenleber, Bakterien WAKSMANS und einigen anderen Bakterien wurde untersucht.

2. Die Alginase, die aus Leber von *Aplysia punctata* hergestellt war, wurde durch Aluminiumhydroxyd C<sub>7</sub> bei schwach saurer Reaktion adsorbiert und durch schwach alkalische Lösungsmittel eluiert.

3. Bei Toluolbakterien von *Bacillus alginovorum* wurde das Vorkommen der Tetramannuronsäure als Hydrolyseprodukt der Alginsäure festgestellt, die in Form seines Bromphenylhydrazone isoliert wurde. Bei lebenden Bakterien von *Bacillus terestalginiticus* konnte die Essigsäure als Endprodukt des Stoffwechsels sichergestellt werden.

4. Es wurde bestätigt, das Reduktionsvermögen des Alginsäureabbauproduktes durch Leberalginase oder Toluolbakterien 26.0–27.8%, d.h. ca ein Viertel der zugegebenen Alginsäure (als Mannuronsäure berechnet) beträgt.

5. Der gefundene Respirationsquotient bei der Oxydation der Alginsäure durch lebende Bakterien stimmt mit dem ausvollkommener Oxydation berechneten gut überein.



$$R:Q=1.2$$

**435. Polyploid plants produced by colchicine.** (Japanese with English résumé). Kazuo FURUSATO. (B.Z. **8**, 1941, 1303–1311, 7 text-figs.).

The colchicine treatment was executed on a number of plants by immersing seeds in 0.02–0.8% solution. The original plant was diploid in all cases, and the tetraploid offspring were got by that treatment, but only in *Petunia violacea* both tetra- and octoploids were obtained. In some other cases the chimerical plant composed of di- and tetraploid branches (*Portulaca grandiflora*, *Petunia violacea*) and that consisting of tetra- and octoploid ones (*Petunia violacea*) were produced.

Seedlings derived from the seeds treated by colchicine are characterized by abnormally gigantic growth of lower part of hypocotyl and root. The microscopical

examination of stem and root has revealed the fact that the gigantic growth is due not to the increase in number of cells composing them, but to the aggrandization of each individual cell. Stomata are much larger in tetra- than in diploids. The measurement of the transpiration ratio has shown that it is much greater in the former than in the latter.

**436. Saxifragaceae.** (Japanese). Hiroshi HARA. (NAKAI-HONDA, Nova Flora Japonica 3, 1939). 152 pp, 37 text-figs.

The author's Saxifragaceae in this work are taken in their narrow sense, and correspond somewhat to Saxifragoideae—Saxifrageae of ENGLER. They include the following genera: *Astilbe* (14 species), *Rodgersia* (1), *Tanukawa* (1), *Saxifraga* (7), *Peltoboykinia* (2), *Neoboykinia* (1), *Chrysosplenium* (15), *Tiarella* (1) and *Mitella* (11), many other genera which are generally included among the Saxifragaceae being excluded out. *Astilbe* is divided into 3 series and includes 14 species in all, of which *A. Okuyamae* is a new species and provided with a Latin diagnosis. *Saxifraga* contains 4 subgenera, each of which is divided into a certain number of sections and includes 17 species in all. *Chrysosplenium* is divided into 2 sections and includes 9 series and 15 species in all. *Mitella* is divided into 3 sections, one of which is further divided into 2 series. The number of species in this genus is 11 in all. Each of the remaining genera contains 1 or 2 species.

The distribution of the species in the whole world is pointed out in a table.

**437. Observationes ad plantas Asiae Orientalis (XVII), (XVIII), (XIX).** (With Japanese résumé). Hiroshi HARA. (J. Jap. B. 17, 1941, 18-26, 119-129, 335-347, altogether 3 text-figs.).

Among the plants contained in this paper the following are new species and described: *Chrysosplenium glossophyllum*, *Lobelia Hancei*, *Hemerocallis vespertina*, *Coronopsis Wrightii*. Besides, several new combinations are made up by the author.

**438. Microchemical test of urusiol and similar substances.** (Japanese with English résumé). Morisige HARADA. (B.S., F.T., K.I.U. 9, 1931, 263-276).

In the latex of *Rhus vernicifera* the urusiol is contained, and many plants belonging to the Anacardiaceae are known to contain similar substances. They are easily detected by adding to the latex successively absolute alcohol and 15-50% nitric acid, when it soon becomes reddish. By using 5-10% caustic potash, 1-5% copper acetate or 1-5% ferric chloride instead of nitric acid it may also be easily detected, because by the first reagent the latex becomes coloured deep green, by the second purple black and by the third black. These three reagents may be used for the same purpose without applying any alcohol beforehand. A weak solution of nitric acid (e.g. 20%) lets turn the latex red-brown without applying alcohol beforehand, though the reaction goes slowly, for instance, 2 minutes in 20% solution. It must however be remarked that the nitric acid solution without alcohol seems to react upon other substances than the urusiol.

**439. Quantitative investigations on the tissues of fruits of Japanese *Rhus* plants, with special reference to their wax content.** (Japanese with English résumé). Morisige HARADA. (B.S., F.T., K.I.U. 9, 1941, 327-336, 3 tables).

The quantity of wax contained in the *Rhus* fruit is proportional to the size of its mesocarp, and the latter is in its turn closely related to the size of the fruit and seed, especially the latter, so that we may estimate to a certain extent the greater or less

content of wax by measuring the area of the part of the mesocarp containing it, shortly before the fruit ripening. That quantity may however be better judged in dried ripe fruits by comparing the volume and weight of the mesocarp of fruit with those of the latter itself. The wax content is then denoted by  $\frac{\text{weight of wax}}{\text{weight of fruit}} \times 100$  (below called wf%). The author's results of quantitative estimation of wax content in various species and strains of Japanese *Rhus* plants are shown in two tables. According to the data contained therein some strains of *Rhus succedanea* were observed among others to be richest in wax, thus in Budôhaze wax 0.065 g per fruit, fruit 0.2862 g, wf% 23, in Syôwahukuhaze wax 0.0503 g per fruit, fruit 0.1499 g, wf% 34. In respect to other *Rhus* species, in *R. vernicifera* wax 0.0178 g per fruit, wf% 16, in *Rhus Toxicodendron* var. *vulgaris* wax 0.0035 g, wf% 18, in *Rhus silvestris* wax 0.0100 g, wf% 15, in *Rhus trichocarpa* wax 0.0016 g, wf% 13, etc.

**440. Materials for a rust flora of Manchoukuo.** (With Japanese résumé). Naohide HIRATSUKA. (T.S.N.H.S. 16, 1941, 193-208).

A certain species from each of the following genera are enumerated, viz. *Uredinopsis* (2 species), *Milesina* (1), *Thekopsora* (3), *Pucciniastrum* (4), *Melampsora* (2), *Phakopsora* (2), *Cronartium* (2), *Chrysomyxa* (1), *Coleosporium* (13), *Nothoravenelia* (1), *Rostrupia* (1), *Gymnosporangium* (1), *Phragmidium* (3), *Tranzschelia* (1), *Triphragmium* (1), *Xenodochus* (1), *Uromyces* (15), *Puccinia* (35), *Aecidium* (3).

**441. Materials for a rust-flora of Formosa.** (With Japanese résumé). Naohide HIRATSUKA. (B.M.T. 55, 1941, 267-273).

From each of the following genera a certain number of species are enumerated: *Uredinopsis* (1 species), *Milesina* (2, 1 of which *M. formosana* HIRATSUKA fil. et HASHIOKA is a new species), *Pucciniastrum* (2), *Melampsora* (1), *Phakopsora* (1), *Crossospora* (1), *Coleosporium* (2), *Phragmidium* (1), *Ravenela* (1), *Uromyces* (4), *Puccinia* (11), *Endophyllum* (1), *Uredo* (3), *Aecidium* (1).

**442. Pflanzenoekologische Untersuchungen über die höheren Wasserpflanzen des Suwasees, besonders im Herbst.** (Mit japanisch. Zfg.). Kinji HOGETSU. (B.M.T. 55, 1941, 66-78).

Der Verf. hat im Suwasee die Versuche ausgeführt, welche den früher von ihm im Kizakisee gemachten gleichartig sind. (Vgl. diesen JOURNAL 11, (10), Nr. 28). Die gleichen Arten Pflanzen wie früher wurden dabei benutzt.

Danach liegt die Tiefe der maximalen Assimilation immer gering, und zwar 1 m, was zum schwachen Licht bei der Versuchszeit und des trüben Wassers zuzuschreiben ist. Die Tiefe des Kompensationspunktes beträgt bei *Myriophyllum* und *Ceratophyllum* je 4-5 m, bei *Ranunculus* 3-4 m, und bei *Nitella* 6-8 m. Die relative Lichtintensität an dem Kompensationspunkt beträgt bei *Myriophyllum* und *Ceratophyllum* 3-0,5%, bei *Ranunculus* 6-3% und bei *Nitella* 0,5% oder darunter. Auf Grunde seiner Versuchsergebnisse über die Assimilationsleistung in verschiedenen Tiefen, teilte er seine Versuchspflanzen zu drei folgenden Gruppen ein, nämlich, hellstenophotischer (*Ranunculus*), euryphotischer (*Myriophyllum* und *Ceratophyllum*) und dunkelstenophotischer (*Nitella*) Typus, ebenso wie bei den Untersuchungen im Kizakisee.

**443. Nuntia ad floram japoniae XLIV.** (With Japanese résumé). Masazi HONDA. (B.M.T. 55, 1941, 201-204).

The following new names, forms, combinations, as well as varieties are noticed: *Vincetoxicum Makinoi* HONDA nom. nov., *Glechoma hederacea* L. var. *minor* HONDA var. nov., *Minulus inflatus* NAKAI var. *orecophilus* HONDA var. nov., *Persicaria Yokusaiana* NAKAI var. *albiflora* HONDA, form. nov., *Abelia spathulata* S. et Z. var. *macrophylla* (NAKAI) HONDA comb. nov., *Schizocodon magna* HONDA form. *leucantha* (NAKAI) HONDA comb. nov., *Viola grypoceras* A. GRAY var. *pubescens* NAKAI form. *hemileuca* HONDA form. nov., *Rhododendron linearifolium* S. et Z. var. *macrosepalum* MAKINO form. *leucantha* HONDA form. nov., *Hydrangea luteo-venosa* KOIDZUMI var. *yakusimensis* (MASAMUNE) HONDA comb. nov., *Heterotropa lutchuensis* (T. ITO) HONDA comb. nov.

**444. Eine Variation in der Blattstruktur von *Pinus densiflora* SIEB. et ZUCC.** (Mit Japan. Zfig.). ISAO HURUSAWA. (B.M.T. 55, 1941, 109-111, 2 Abb.).

Die in Japan weitverbreiteten Kieferarten, *Pinus Thunbergii* und *P. densiflora* sind auf dem Grunde der anatomischen Struktur von Nadeln unterscheidbar, insofern als bei der ersteren Art die Harzgänge sich tief im Mesophyll eingesenkt befinden, während bei der letzteren sie unmittelbar unter der Oberhaut gelagert sind. Nun hat der Verf. neuerdings bei einem Bergkamm zwischen Kōtuke und Simotuke die *Pinus densiflora*-Individuen aufgefunden, deren Nadeln ziemlich dick wie bei *P. Thunbergii* und oft zu dreien gruppiert sind. Die anatomischen Studien derselben haben gezeigt, dass dabei die Harzgänge im allgemeinen unter der Oberhaut gelagert, aber einige derselben im Mesophyll eingesenkt entwickelt sind, wie bei *P. Thunbergii*. Der Verf. hält diese Kiefer für eine Form von *Pinus densiflora* und nennt sie *P. densiflora* f. *subtrifoliata* f. nov.

**445. Materials of Micronesian higher fungi.** (Japanese with Latin diagnoses). ROKUYA IMAZEKI. (J. Jap. B. 17, 1941, 175-184, 6 text-figs.).

Some species from each of the following genera are enumerated: *Hirneola* (1 species), *Stereum* (2), *Fomes* (4, of which *F. mangrovicus* is a new species), *Ganoderma* (3), *Gloeoporus* (1), *Hexagona* (1), *Polyporus* (9), *Polystictus* (3), *Trametes* (3), *Lentinus* (3, of which *L. palauensis* is a new species), *Panus* (2), *Schizophyllum* (1).

**446. On the germination of spores in *Rhodoglossum pulchrum* (KUTZ.) SETCH. et GARDN. and *Iridophycus cornucopiae* (POST. et RUPEL) SETCH. et GARDN.** (Japanese with English résumé). SHUMPEI INOH. (B.M.T. 55, 1941, 25-38, 1 pl. and 11 text-figs.).

*Rhodoglossum pulchrum* and *Iridophycus cornucopiae*, formerly ranked under one and the same genus *Iridaea* produce the tetra- and carpospores of equal size. The spores of the two species above indicated are distinguished from each other by their somewhat different size ( $23\mu$  in *Rhodoglossum* and  $23\mu$  in *Iridophycus*) and by the earlier development of spores in the latter than in the former. The mode of development of spores agrees perfectly to each other in both species. The germination of spores follows the so-called disc-type ("Haftscheibetypus" of KYLIN, which is common in the Gigartinales. In this process the spore-cell, without any change of its size, is divided into a number of cells, first by a perpendicular wall, and then by some irregularly orientated walls. The germling forms usually a hemispherical disc with a pretty regular outline, and gradually grows up into a more or less flat expanded disc, i.e. the latter always arises by the direct segmentation of the spore-cell. After some 20 days the first upright shoot develops from the meristem in the disc, and also many



hyaline hairs spring up on its surface. When several germings develop near each other, they fuse together to form a large disc.

**447. Embryological studies in *Eusargassum*. (Preliminary note).** (Japanese with English résumé). Shumpei INOH. (B.M.T. 55, 1941, 85-93, 9 text-figs.).

Formerly the author has studied the rhizoid formation in a certain species of *Sargassum*, but his investigation was not done on any species of the subgenus *Eusargassum* which abounds in the species number. The present study is concerned with the same process in two species belonging to this subgenus, whose specific names are not yet known. In one of them which is dioecious the rhizoid formation begins to take place after the division of the rhizoid cell into 16 cells (16-cell type), while in another which is unisexual the rhizoid-cell is divided into 8 cells and no further, and 8 rhizoids are developed from them (irregular 8-cell type). The two types above indicated are those commonly observed in *Sargassum*, while the so-called radiate 8-cell type was seen only in *Sargassum Horneri*.

**448. On the germination of spores in the Nemalionales.** (Japanese). Shumpei INOH. (B.Z. 9, 1941, 505-510).

The author's studies refer to four species of Nemalionales, viz. *Nemalion vermiculare* SUR., *Scinaria japonica* SETCH., *Galaxaura falcata* KJELLM. and *G. fastigiata* DESCNE. The mode of development follows the well-known "Keimschlauchtypus" of KYLIN, where the germinating spore develops into a filamentous germling composed of a row of cells. In *Nemalion vermiculare* the spore is emptied of its content during the course of its development, which wanders out into the germ-tube, but in three other species no such process occurs, and the spore-cell forms the end of the germling as its single basal cell, as in the case of *Chantransia*, *Rhodochorton* and *Acrochaetium*, which are considered as the lowest members among the Nemalionales.

**449. *Nephromae novae* in Japonia.** Sunao INUMARU. (A.PT.G. 10, 1941, 64-66, 2 text-figs.-groups).

*Nephroma Koidzumii* is a new species, and *N. laevigatoides* GVELNIK f. *castaneum* is a forma nova. *N. denticulatum* (WAINIO) GVELNIK is fully described with illustrations. *N. sublusitanicum* GVELNIK is also enumerated.

**450. Fragmenta lichenologica IV.** (Japanese). Sunao INUMARU. (A.PT.G. 10, 1941, 68-70).

*Nephroma Koidzumii* sp. nov. from Sachalien is described.

**451. Polypodiaceae-Dryopteridoideae I.** (Japanese). Hiroshi ITO. (NAKAI-HONDA, Nova Flora Japonica No. 4, 1938). 234 pp, 35 pls.

What the author calls here the subfamily Dryopteridoideae includes simply the genus *Dryopteris* in its wide sense, as it was held till very recently, i.e. the genus *Dryopteris* of CHRIST and *Nephrodium* of DIELS.

Under this subfamily the following 14 genera are included according to the author: *Dryopteris*, *Ctenitis*, *Cornopteris*, *Acororomohra*, *Rumohra*, *Leptoromohra*, *Hypodematum*, *Thelypteris*, *Glaphyropteris*, *Phegopteris*, *Gymnocarpium*, *Leptogramma*, *Cyclosorus* and *Meniscium*.

With a few exceptions each genus is divided into a number of sections, and in many cases each section into a number of subsections; almost all sections and subsections are those which have been established by the author himself. The number of

species contained in this work is as follows: *Dryopteris* 50+1(?), *Ctenitis* 17, *Cornopteris* 4, *Acrosumohra* 2, *Rumohra* 10, *Leptorumohra* 2, *Hypodematum* 1, *Thelypteris* 13, *Glaphyopteris* 4, *Phegopteris* 5, *Gymnocarpium* 4, *Leptogramma* 1, *Cyclosorus* 10, *Meniscium* 4, i.e. 127+1(?) in all, of which the largest number is contained in *Dryopteris*.

35 plates at the end of the work show sketches of scales in the petioles and mid-ribs, scales and hairs in costae and veins, as well as photographs of fronds in all species treated in this work.

**452. Ecological studies of peat bog III. The peat bog of Suirennuma.** (Japanese with English résumé). E. IWATA. (E.R. 7, 1941, 27-50, 13 text-figs.).

Suirennuma peat bog in Mt. Hakkôda,  $\pm 980$  above sea level, which is developed around five ponds, occupies an area of  $\pm 1$  ha., and is surrounded by the forest of *Abies Mariesii*. Six plant associations are there distinguishable, which are arranged quite regularly in concentric manner with each of the ponds just cited as the centre. They are *Nymphaea tetragona* var. *angusta* sv. *orientalis* association in deep part of waters, *Mengyanthes trifoliata* association in peripheral less deep part of waters, *Lobelia sessiliflora*—*Sphagnum* association in the regions surrounding the ponds, *Rhynchospora Yasudana*—*Carex stellulata* association forming large zones of grass lands around the preceding, scrubs of *Menziesia ciliicalyx* var. *multiflora*—*Ilex Sugeroki* subsp. *brevipedunculata* association in the further peripheral part, and finally the forest of *Abies Mariesii* surrounding the border of the peat bog.

The plant associations above cited are not quite stable and are concerned in the process of development.

**453. Synecological studies of the river-bank forests.** (Japanese). Takumi KAGAWA. (E.R. 7, 1941, 89-107, 14 text-figs.).

The river-bank forests were studied from the synecological viewpoint in respect to the upper stream of certain rivers in the Prefectures Miyagi and Yamagata.

First of all, it must be remarked that on account of the abundant rainfall as well as the steepness of land in general in Japan the river-bank is very often visited by flood which will act more or less destructively. Consequently the river-bank should be distinguished into unstable, intermediate and stable land-pieces. Since the unstable part of the river-bank is subjected almost every year to the destructive action of flood, plants which are seen growing there are chiefly annual ones or perennial ones which can be firmly fixed to the soil by their rhizomes, etc. Shrubs prosper there, among which various species of *Salix* are predominating.

The *Pinus densiflora*-forest in the river-bank may be considered as the soil climax association. It may be developed in either of the two following ways: (1) unstable land where at first only the herbs were growing becomes gradually higher by the deposition of sand, whereupon the association of shrubs there originates and is followed by *Pinus densiflora*, (2) after a heavy inundation which will wash away fine soil particles the pebbles are exposed externally, whereupon xerophytic plants as well as *Pinus densiflora* will grow there as dominating plants.

The islets amidst the stream are naturally much exposed to the action of flood, and since they are generally untouched by men's hands, they are most suitable for studying the natural fate of the river-bank plants. Whilst the plant-associations are developed band-like along the stream, the distribution of associations in the river islet may be quite irregular on account of topographical change worked by flood.

**454. On the gametophytes of some Japanese species of Laminariales III-IV.** Tiyoiti KANDA. (Sc. P., I.A.R., F.S., H.I.U. 2, 1941, 155-193, 3 pls. and 26 text-figs.; ibid. 243-308, 1 pl. and 13 text-figs.).

The results of the author's culture experiments of the gametophytes and the young sporophytes of several Laminariales, *Eisenia bicyclis*, *Ecklonia cava* and *stolonifera*, *Eckloniopsis radicata*, *Undaria Peterseniana*, *Laminaria angustata* and *Agarum cribrosum*, are presented in this paper.

Some important facts contained in this paper are shortly reviewed below.

*Eisenia bicyclis* and *Ecklonia cava* coincide closely in their external features, except the fact that in the former the formation of two arms takes place at the transitional region of the stipe. According to the author's result of the culture experiments, their female gametophytes are mostly uni- and bicellular, and the sexual maturity is reached soon after the germination, for instance, after 8 days. Such fact is in contrast to what the preceding authors have announced. Further, they could not observe the cilia in the zoospores of *Eisenia arborea* and *Pelagophycus pora*, while the present author was able to observe them in the zoospores of all species studied by him. He thinks that the negative results of certain authors in that respect might be due to the poisonous action of mucilaginous brown juice oozing out of the thallus of *Eisenia*, *Ecklonia* and many other Laminariaceae, which acts so as to deprive the zoospores of their cilia. The eye-spot was wanting always, as the author has stated formerly in many forms.

It is very remarkable that in *Ecklonia cava* and *stolonifera*, as well as in *Eckloniopsis radicata* the basal cell of young sporophyte grows down gradually within the already emptied oogonium cavity to fill up its greater part. This basal cell undergoes no cell-division, nor is the rhizoid produced from it.

The gametophytes and the young sporophytes of *Undaria Peterseniana* were also studied, but there are no special features to be here specially mentioned.

The female gametophytes of *Laminaria angustata* are mostly unicellular. The male gametophytes do not show any special feature in comparison to those of other Laminariales. In culture experiments it was seen that the zoospores reach their maturity comparatively within a short time (7-9 days), and the formation of male and female gametophytes was completed after 14 days.

*Agarum cribrosum* and *Costaria costata* agree perfectly in the shape of their gametophytes, especially in that of the male ones, which are characterized by their loosely branched filamentous structure. In *Agarum cribrosum* the author was able to detect the cilia in its zoospores and the absence of the eye-spot was also here ascertained, as in other species studied by him.

**455. The KANEHIRA-MATUSIMA collection of New Guinea plants. I.** (With Japanese résumé). Ryôzô KANEHIRA. (B.M.T. 55, 1941, 249-266, one map and 13 text-figs.).

In 1940 the author, together with S. MATSUDA, made a botanizing tour in Dutch New Guinea. The places of their botanizing are shown in a map. In this first part the species belonging to the genus *Freycinetia* which were collected in this expedition are enumerated or described. Among 13 species in all the following are new and described with illustrations: *Freycinetia cruciger*, *F. Inoue*, *F. laciniata*, *F. latiauriculata*, *F. platyphylla*, *F. rectangularis*, *F. spinellosa*.

**456. Studies on the sex of hymenomycetous fungi.** (Japanese with English résumé). Eikichi KAWAMURA. (B.S., F.T., K.I.U. 9, 1941, 336-382, 10 text-figs.).

In *Pleurotus ostreatus* and *Polystictus sanguinea* the mycelium derived directly from a single basidiospore is composed of uninucleate cells (haploid) and carries no

clamp-connections, while the diploid mycelium, which is produced by the pairing of compatible haploid mycelia, is made up of cells, each containing paired nuclei, possesses the clamp-connections, and will give rise to the fruit-body.

Both species of fungi above cited are thus heterothallic and are characterized by the tetrapolarity. The behaviour of each fungus in and after the mating is in perfect accord with what has been hitherto observed in other tetrapolar fungi (KNIEP, VANDENDRIES, etc.). Thus, for instance, in *Pleurotus ostreatus* the four compatible genotypes in haploid mycelium may be represented as AB, ab, Ab and aB, and consequently the diploid mycelium is either (AB+ab) or (Aa+aB). The following haploid×diploid matings were done, viz. (1) AB×(AB+ab), (2) ab×(AB+ab), (3) Ab×(AB+aB), (4) aB×(AB+aB), (5) AB×(Ab+aB), (6) ab×(Ab+aB), (7) Ab×(AB+ab), (8) ab×(AB+ab). In the first 4 combinations, (1), (2), (3) and (4) ("legitimate unions") the haploid mycelium becomes soon completely diploidized all around the periphery, while, on the contrary, in the four remaining combinations ("illegitimate unions") no diploidization takes place, except in a few restricted portions. In one of the latter combinations, e.g. Ab×(AB+ab) the diploidized mycelium was found to possess the constitution (Ab+aB), and neither (Aa+AB) nor (AB+ab). In such illegitimate unions the mycelium of the haplont was retarded in its growth, much delicate and ran irregularly in comparison to normal mycelium, though in later stage it may recover its vigorous growth and be converted into rigid patchy mycelium.

*Polystictus sanguinea* forms oidia both on primary and secondary mycelia. Those of the former kind are uninucleate and produce uninucleate mycelia, while those of the latter kind are binucleate and produce binucleate mycelia. The diploidization of haploid mycelium by mating the latter with a theoretically incompatible mycelium can be executed just as in *Pleurotus ostreatus*, and in such illegitimate mating the mycelium was observed to run irregularly.

**457. *Plantae novae ex Manchuria nec non China Boreale.*** (With Japanese résumé). Masao KITAGAWA. (J. Jap. B. 17, 1941, 234-241, 1 text-fig.).

The following new species of plants from Manchuria are described: *Lasiogrostis caduciseta*, *Roegneria multiculmis*, *Carex hankaënsis*, *Veronica glabrifolia*, *Ligularia biceps*.

**458. *Melampyra japonica.*** (Japanese). Siro KITAMURA. (A.P.T.G. 10, 1941, 1-14, 3 text-figs.).

HANDEL-MAZZETTI recognizes in his "Symbolae sinicae" (1936) only three Japanese species of *Melampyrum*, viz. *M. roseum*, *laxum* and *ciliare*. The present paper will serve as the correction of such statement. The author enumerates the following: *M. roseum* MAX. var. *alpinum* KITAMURA var. nov. (Korea), var. *hirsutum* BEAUV., var. *longisepalum* TUYAMA, var. *brevidens* KITAMURA var. nov., *M. laxum* MIQUEL var. *yakusimense* (TUYAMA) KITAMURA comb. nov., var. *longitubum* NAKAI, *M. arcuatum* NAKAI, *M. ciliare* MIQUEL, var. *japonicum* (FR. et SAV.) KITAMURA comb. nov., *M. ovalifolium* NAKAI, *M. setaceum* NAKAI, var. *B. latifolium* NAKAI, *M. Nakaiianum* TUYAMA, *M. Kawasianum* KITAMURA sp. nov.

**459. An enumeration of Compositae of Formosa.** Siro KITAMURA. (A.P.T.G. 10, 1941, 15-37).

Several species from the following genera are enumerated: *Echinops*, *Saussurea*, *Hemistepta*, *Cirsium*, *Leibnitzia*, *Perya*, *Ainsliaea*, *Xanthium*, *Picris*, *Taraxacum*,



*Ixeris*, *Lactuca*, *Crepidiastrum*, *Youngia*, *Lampsana*, *Prenanthes*, *Sonchus* and *Hieracium*.

**460. Hymenogastrineae et Phallineae.** Yosio KOBAYASI. (Japanese). (NAKAI-HONDA, Nova Flora Japonica No. 2, 1938). 90 pp, 3 pls. and 68 text-figs.

In this work the two suborders, Hymenogastrineae and Phallineae are treated. The first suborder includes four families, Rhizopogonaceae, Hymenogastraceae, Hysterangiaceae and Hydnangiaceae, and the second the two families, Clathraceae and Phallaceae.

The Rhizopogonaceae contain the genus *Rhizopogon* (4 species), the Hymenogastraceae the genera *Hymenogaster* (2 sp.) and *Octaviania* (3 sp.), the Hysterangiaceae the genera *Hysterangium* (1 sp.) and *Protuberia* (2 sp.). The Clathraceae contain the genera *Simblum* (2 sp.), *Clathrus* (3 sp.), *Ileodictyon* (1 sp.), *Linderia* (2 sp.), *Aseroe* (2 sp.), *Lysurus* (1 sp. and 1 var.), *Pseudocolus* (2 sp.). The Phallaceae contain the genera *Mutinus* (1 sp.), *Jansia* (1 sp.), *Echinophallus* (1 sp. and 1 var.), *Phallus* (7 sp. and 1 var.), *Dictyophora* (2 sp.).

Among the species and varieties which are enumerated there are some named by the author himself.

**461. The genus *Cordyceps* and its allies.** Yosio KOBAYASI. (Sc. Rpts., T. BR. D. No. 84, 1931, 53-260, with numerous text-figs.).

The present paper is chiefly a monograph of the Japanese species of the genus *Cordyceps*. It consists of two parts.

Part I (53-216) which occupies the greater part of the paper is devoted to the genus *Cordyceps*. First of all, the following taxonomic characters are treated, viz. endosclerotium, mycel, stroma, perithecium, fertile part, ascus and ascospore. Then comes the principal part, i.e. the description of species. For the classification the author proposes a new system. The genus is divided into three subgenera according to the character of ascospores, and each subgenus is further divided into groups, sections and subsections.

The first subgenus *Ophiocordyceps* is characterized by the ascospore which is elongated, septate and does not split into articles. The second, *Eucordyceps* is characterized by the elongated ascospore which splits into a certain number of articles, and the third *Neocordyceps* by the ascospore splitting into articles which become fusoid with acute ends. The species contained in each subgenus are enumerated or described with illustrations. The whole number of species contained in the paper is 137, of which 8 are new, viz. *C. hokkaidoensis*, *C. takaomontana*, *C. arachneicola*, *C. takaoensis*, *C. nikoensis*, *C. graciloides*, *C. neo-Volkiana* and *C. obliqua*.

Since TULASNE the conidial state of *Cordyceps* was treated as a special genus *Isaria*. Later researches have shown that many other genera of Deuteromycetes belong to *Cordyceps*. A number of such conidial genera are enumerated; to cite a few examples. *Spicaria* is the conidial state of *Cordyceps Erotyli*, *Sporotrichum* that of *C. hokkaidoensis*, *Cephalosporium* that of *C. martialis*, etc., etc.

The author announces his experiment of culture of *C. militaris* in a rice-grain decoction medium from the spores onwards till the formation of stroma, thus proving that *Cordyceps* may be cultured in saprophytic way.

In the next place the author divides *Cordyceps* into four groups according to the difference of hosts, viz. sclerotia of *Claviceps*, fruit-body of *Elaphomyces*, spiders, and insects.

The geographical distribution of *Cordyceps* in the whole world is indicated. 54 species are found in Japan, lying in the holoarctic zone.

Part II of the paper is devoted to entomogenous Deuteromycetes from Japan. The following are new: *Hirsutella neo-Volkiana*, *Hymenostilbe Odonatae*, *Isaria takamizusanensis*, *I. gracilioides*, *I. kunitatiensis*, *I. yokohamensis*, *I. macroscyticola*, *I. perexigua*, *Polycephalomyces* (gen. nov.) *formosus*, *Stibella larvarum*, *Sporotrichum hokkaidoense*.

The index which is mentioned in the content and might be very convenient for finding the specific names, is wanting in the text.

**462. Contributiones ad cognitionem florum Asiae Orientalis.** (Continued). G. KOIDZUMI. (A.P.T.G. 10, 1941, 54-63).

*Halosciasium* gen. nov. (Umbelliferae) *crassum* sp. nov., *Abelia serrata* S. et Z. var. *obspathulata* var. nov., *Hypericum aemulans* sp. nov., *Euonymus dolichophyllus* sp. nov., *Sorbus gracilis* (S. et Z.) KOCH var. *tomentella* var. nov., var. *crassa* var. nov., *Sorbus viminalis* sp. nov., *Pyrus Mayebaratorii* sp. nov., *P. yamaguchensis* sp. nov., *P. kumaensis* sp. nov., *P. oblongolanceolata* sp. nov., *P. tajimensis* sp. nov., *P. takuhokuensis* sp. nov., *P. Saideana* sp. nov., *Arundinaria Kotohsuzusiana* sp. nov., *A. procumbens* sp. nov., *Pleioblastis dimorphophylla* sp. nov., *P. ikarugaensis* sp. nov., *P. Sadawoana* sp. nov., *Semiarundinaria fortis* sp. nov.

**463. Studies on the germination of seeds of weeds, with special reference to the influence of light and the change of temperature on the germination.** (Japanese). Mantarô KONDÔ and Yasuo KASAHARA. (A.S. 32, 1941, 357-397, 3 figs. and 14 tables).—**Relation between the after-ripening of seeds as well as the change of temperature and the germination.** (Japanese). By the same authors. (Ibid. 398-408, 1 table).

Experiments were executed in respect to seeds of 114 species of weeds belonging to 26 families. The bed for germination was either filter-paper or river sand. The whole was put either in dark or diffused light of the room. Of all weeds experimented upon many have germinated best under diffuse light. Many, though not all, will germinate best at 25°C, provided they are placed at the place of lower temperature (15-20°) during some time (5-10 days). In some cases, by repeating such changes of temperature all seeds were induced to germination. Among some weeds which are not apt to germinate very well on filter-paper bed, many will do so, when transferred to river sand bed.

On the whole we may say that the excellent germination of seeds will be induced, if those which have passed a certain time duration after harvest to make their after-ripening, are sown in river sand and subjected to the temperature change.

Some seeds which are not apt to germinate soon after the harvest may germinate well after one year, when they have completed their after-ripening. The optimum temperature of germination for such seeds was 20°C. If seeds which are hardly able to germinate at 15°C, 20°C or 25°C will be subjected to 15° repeatedly, the germination may take place owing to such stimulus.

**464. On the storage of seeds of forest trees I.** (Japanese). Mantarô KONDÔ, Ryûhei TAKAHASHI and Yûsi TERASAKA. (A.S. 32, 1941, 283-303, 5 text-figs.).

According to the results of the authors' studies the storage of seeds of the Cupuliferae for a number of years is difficult. Thus, for instance, the storage under dry condition is rather harmful than favourable. Though various methods were tried

for this purpose, almost all were useless, except the following: firstly, if seeds which are mixed up with river sand are buried deeply under ground, they may retain their life for one year; secondly, if they are stored up under 0–5°C they may live for two years.

**465. Chromosome doubling in *Secale*, *Haynaldia* and *Aegilops* by colchicine treatment.** (Japanese with English résumé). NORIO KONDO. (J.J.G. 17, 1941, 46–54, 7 text-figs.).—**Colchicine treatment of *Secale*, *Haynaldia*, *Aegilops*.** (Japanese). By the same author. (B.Z. 12, 1941, 1915–1916, 1 text-fig.).

The author's methods of colchicine treatment was that of SEARS (1939) somewhat modified as well as the dropping method. The diploids used for the experiments were *Secale cereale*, *Haynaldia villosa*, 4 species of *Aegilops* and 1 sterile species hybrid *Aegilops caudata*×*Ae. umbellulata*, and the tetraploids were got by this treatment. The tetraploids are characterized by their gigantism in comparison to diploids, especially epidermal cells of leaves in the former are 1½ times longer than those in the latter. Abortive pollen grains are more abundant in tetra- than in diploids, but good pollen grains in the former are much larger than those in the latter. In the PMC of the tetraploids in *Secale cereale* and *Haynaldia villosa* the chromosome configuration 2IV+10II and 1IV+1III+10II+1I are most frequent. The grade of fertility in tetraploids is always inferior to that of diploids, not much so in *Aegilops*, but very much so in *Secale cereale* (diploid 64.8%, tetraploid 5.9%). The sterile species hybrid *Aegilops caudata*×*Ae. umbellulata* is an exception in this respect, because while its diploid (F<sub>1</sub>) is entirely sterile, its amphidiploid (2n=7+7) shows 63.6% fertility.

**466. Beziehungen zwischen der Transpiration, Minera'stoffenahme und Aschenanhäufung der Pflanze I. Verhältnisse bei ungleicher Beleuchtung.** (Japanisch m. deutsch. Zfg.). RIICHIRO KÔKETSU, Takayuki SIOMI und Yoshifumi ARIGA. (B.S., F.T., K.I.U. 7, 1941, 308–326, 6 Tabellen).

Die vergleichenden Versuche an Reis und Weizen unter den Bedingungen gleicher Nährlösungskonzentration und ungleicher Beleuchtung wurden ausgeführt, um die im obigen Titel genannten Verhältnisse klarzustellen. Dabei wurden die Nährlösungsverdampfungs- und die Rückstandsverachtungs-Methode angewendet.

Nach den Verffs. Versuchen sind die parallelverlaufenden Beziehungen zwischen der Transpirationsgrösse und der Menge des aufgenommenen Mineralstoffes kaum nachweisbar. Weiter, obgleich viele Forscher von der Ansicht sind, dass man die Menge der aufgenommenen Mineralstoffe nach dem Aschengehalt der Pflanzen wohl beurteilen kann, dürfte solche Meinung keineswegs ganz richtig sein. Denn nach den Studien Verffs. und von den anderen, ist der Verlust der Mineralstoffe ("ihr Entfliehen") nicht unerheblich, sodass um die Menge des aufgenommenen Mineralstoffe richtig zu beurteilen, man die direkte quantitative Untersuchung auszuführen brauchen wird.

Die Menge des aufgenommenen und angehäuften Mineralstoffes hängt sowohl von dem Beleuchtungsgrade als von der Pflanzenarten ab. Bei den vergleichenden Versuchen unter schwacher und starker Beleuchtung wurde es nämlich einerseits festgestellt, dass bei beiden, Reis und Weizen, pro Einheit der transpirierten Wassermenge ausgerechnet, die Menge des aufgenommenen Mineralstoffs grösser ist unter schwacher als unter starker Beleuchtung. Andererseits wurde es nachgewiesen, dass auch pro Einheit der transpirierten Wassermenge ausgerechnet, die Anhäufung des Mineralstoffes bei Reis grösser ist unter schwacher als unter starker Beleuchtung, während es bei Weizen gerade umgekehrt ist. Warum solcher bemerkenswerter Unterschied zwischen Reis

und Weizen bestehen mag, ist noch nicht ganz klar, und darüber konnten die Verff. nur die Vermutung aussprechen.

**467. Phage-produced resistance strains of *Bacillus aroideae* III. Culture in soils and host plants.** (With Japanese résumé). Takashi MATSUMOTO. (T.N.H.S.F. 31, 1941, 145-154, 1 text-fig.).

Some time ago the author has announced that when *Bacillus aroideae*, together with its bacteriophage, is cultured in a nutrient solution, the resistance strains come soon into existence, and consequently the phagic action disappears rapidly, and further, when the culture is made in clayish soils instead of the solution, the phagic action may continue much longer (cf. this JOURNAL 11, (17), No. 55). However, even in the latter case, the active principle is easily impaired above 25°C, usually within a few days. Through the culture on the tissue of host plants (radish discs), however, not only does the active principle maintain itself much longer, but also it accumulates rather abundantly. The prevailing temperature was then  $\pm 31^\circ\text{C}$ . If after a certain duration of time the culture is placed under 13-19°, the active principle can remain unimpaired for a considerably longer time, even in the case of soil culture.

**468. Serological studies on the distribution and concentration of tobacco mosaic virus in host plants I. Measurement of virus after 2-4 days.** Takashi MATSUMOTO. (T.N.H.S.F. 31, 1941, 201-215, 2 text-figs.).—**II. Measurements of virus 5-14 days after inoculation.** By the same author. (Ibid. 275-285, 1 text-fig.).

In order to study the mode of distribution of tobacco mosaic virus in various organs of the host plant, the author has used the precipitin method for its detection.

The test antigen was prepared by crushing the plant tissue to be tested with the addition of saline, then centrifuging the juice got by crushing, adding to it silicious earth and again centrifuging. The antiserum was prepared by injecting rabbits directly with tobacco mosaic virus or with the juice of zinnia plants which were previously inoculated by the latter.

The results of the author's experiments are briefly stated below.

The inoculation of the antigen was done on the leaf of young plant, the dilution being generally 1/10-1/20. Through the use of the antiserum as usual it was observed that the active principle accumulates on that leaf 2 days following the inoculation and then wanders either acro- or basipetally or in both ways. So that on the third day the virus is found in the stem, and in the leaves situated below the inoculated ones it was detected first at the fourth day, though meagre and limited in their number. Leaves situated above the inoculated ones hold the virus sparingly, especially on leaves placed immediately above them. The precipitating reaction was observed also in roots 2 days after the inoculation.

After 4-7 days the virus was detected more abundantly in the growing point than in inoculated leaves, but this difference was no more recognizable after 8-10 days or 11-14 days. This may be due, according to the author, to the fact that the quantity of the virus content in inoculated leaves may increase considerably as the time goes on.

After 5-14 days the virus is present abundantly in the leaves situated above the inoculated ones, if that inoculation has been done on young not fully expanded leaves, otherwise no such abundant accumulation will be observed. In the leaves situated below the inoculated ones, on the contrary, no such accumulation was ever seen, even after 11-14 days.



In respect to the concentration of the virus at the top and root the author announces that in the former it is but slightly higher than in the latter.

**469. On the causal organism of a bacterial soft rot of poppy in Formosa.** (Japanese with English résumé). Takasi MATSUMOTO and Seichi HIRANE. (T.N.H.S.F. **31**, 1941, 1-13, 4 text-figs.).

In respect to a bacterial rot disease of opium poppy prevalent in certain localities of Formosa the authors have isolated as the causal organism a rod-shaped *Bacillus* with 4-6 peritrichiate flagella. The comparison of its general character has led the authors to its identification to *Bacillus aroideae* isolated from the radish. In studying this organism under serological and bacteriophageal viewpoint, however, the organisms of radish and poppy were found to differ widely. The organism from the latter does not agglutinate even at the serum in the concentration of 1/10 when tested against the anti-serum of the radish organism, though it does agglutinate in the homologous serum, in all dilutions up to 1/25600. The same behavior is observed in the radish organism which is hardly agglutinable in the antiserum of the poppy organism. Further, though the radish organism is highly susceptible to a bacteriophage got from rotten radishes, as reported formerly by MATSUMOTO, it is quite insensitive to the phage from the poppy. So that the authors are still in doubt, whether the poppy organism is really possible to be identified to *Bacillus aroideae*.

**470. Chromosome studies on *Trillium kamschaticum* PALL. XIII. The structure and behaviour of the kinetochore.** Hajime MATSUURA. (Cyt. **11**, 1941, 369-379, 19 text-figs.).

The organ of the chromosome, "Kinetochore" which is considered to be responsible for the movement of the chromosomes from the equator to the pole and which is called by a variety of names, such as centromere, attachment chromomere, spindle-attachment, etc., etc. is, according to the present author, composed of the chromonema thread (called the kintonema) which is persistent throughout the division and of the matrix surrounding it, and developing fully in metaphase. The behaviour of the kinetochore during the division is perfectly similar to that of the rest of the chromonema (genonema), in the pairing, in the opening out, in the separation of the daughter halves and in the development of the matrix, except the fact that each process is retarded in comparison to that of the chromonema.

**471. On the change of flora in Eastern Asia since Tertiary Period (1). The clay or lignite beds flora in Japan with special reference to the *Pinus trifolia* beds in Central Hondo.** Shigeru MIKI. (Jap. J. B. **11**, 1941, 237-303, 4 pls. and 21 text-figs.).

**472. Floral remains of the Conifer Age at Manzidani near Nisinomiya, Japan. (Preliminary note).** Shigeru MIKI. (Jap. J. B. **11**, 1941, 377-383, 3 text-figs.).

**473. Contributions to the flora of Northern Japan XIV.** (With Japanese résumé). Kingo MIYABE and Misao TATEWAKI. (T.S.N.H.S. **17**, 1941, 49-55, 3 text-figs. with the Index to Contributions I-XIV, 56-68).

The following plants are noticed in this part: *Alnus hirsuta* TURCZ. var. *austro-kurilensis* var. nov., *Betula davurica* PALL. var. *Okubo* var. nov. (bark of the trunk illustrated), *Minuartia rubella* GRAEB., *Silene stenophylla* LEDEB., *Aconitum karafutoense* MIYABE et NAKAI, *Aquilegia parviflora* LEDEB., *Miyakea integrifolia* MIYABE et TATEWAKI.

**474. Studies on the gametophyte of ferns (XVI), (XVII). On the prothallium of thelypteroid ferns.** (Japanese). Siduo MOMOSE. (J. Jap. B. **17**, 1941, 34-51, 12 text-figs.; 96-114, 25 text-figs.).—(XVIII)–(XIX). By the same author. (Ib. 144-163, 12 text-figs.; 284-297, 11 text-figs.).—(XX). **On the prothallium of *Asplenium* and its allied genera.** By the same author. (Ib. 356-369, 12 text-figs.).

*Thelypteris palustris* SCHOTT., *T. nipponica* CHING, *T. Beddome* CHING, *T. glanduligera* CHING, *T. angustifrons* CHING, *T. japonica* CHING, *T. laxa* CHING, *T. oligophlebia* CHING, *Glaphyopteris falciloba* H. ITÔ, *Phegopteris polypodioides* FÉE, *Ph. decursive-pinnata* FÉE, *Ph. bukoensis* TAGAWA, *Gymnocarpium longulum* KITAGAWA, *Currania oyamensis* COPELAND, *Dictyocline Griffithii* MOORE, *Polystichum piceo-paleaceum* TAGAWA, *P. tripterum* PRESL., *Athyrium filix-femina* (L.) ROTH., *A. reflexipinnum* HAYATA, *A. opposipennum* HAYATA, *A. pterorhachis* CHRIST, *Meniscium triphyllum* SWARTZ, *Asplenium Trichomanes* L., *A. incisum* THUNB., *A. oligophlebium* BAKER, *A. prolongatum* HOOKER, *Tarachia caudata* PRESL.

The species above cited are those, of which the structure of the prothallium was studied by the author. The results are contained in the papers above named and are the sequel to many papers formerly published on the same subject. The author should be thanked for his laborious tasks which have cleared up the prothallium structure of so manifold types of ferns. The additional adoption of the gametophytic characteristics in the classification of ferns which has hitherto been based almost exclusively on the structure of the sporophyte, will naturally lead to its conspicuous promotion.

**475. The inheritance of polycaryoptic rice, with special reference to the germination structure of the lemma.** (Japanese with English résumé). Toshitaro MORINAGA and Tatumiko TAZIRI. (J.J.G. **17**, 1941, 57-62, 6 text-figs.).

Polycaryopsis in the rice-plant is the phenomenon, in which more than two caryopses are developed in a spikelet. The present paper deals exclusively with the case of two caryopses in one spikelet.

Some individuals provided with the polycaryoptic character were obtained, and it was observed that this character breeds true in later generations. The cross between such an individual and a normal one has given rise to  $F_1$  plants which are normal in respect to the character under question. The  $F_2$  offspring are in some cases in the ratio normal: polycaryoptic=3:1, but in others the latter are too small in number to be considered as monogenic. The following fact is noticed as remarkable. The portion of the lemma directed towards the embryo of the normal caryopsis has a special histological structure, and is liable to be broken by the pressure of the swelling embryo in the germination, so that the seedling is able to protrude out from there. No such special structure is present at the base of palea, so that for the embryo of the caryopsis in the palea side some difficulty for the germination is presented. Consequently, when the polycaryopses are sown as enclosed in the glumes, simply the embryo of the lemma side will germinate, while the germination of that on the palea will not take place at all or at least be retarded considerably, though both kinds of the caryopsis freed from the glumes will germinate almost equally well.

**476. Charophyta japonica (I)–(IV).** Hideo MORIOKA. (J. Jap. B. **17**, 27-33, 57-70, 130-135, 242-245, 11 Textfig.).

Die in der vorliegenden Arbeit enthaltenen Arten von *Nitella* und *Chara* sind in der Regel in der Umgebung von Tôkyô gesammelt worden. 11 Arten von *Nitella* sind hervorgehoben, von denen die folgenden neu sind, nämlich, *N. oligogyra*, *N. monoli-*

*formis*, *N. spiciformis*, *N. gracilens* und *N. musasiensis*, *N. coreana* (aus Korea). Inbezug auf *Chara* sind 4 Arten erwähnt.

**477. Preliminary note on the chromosome number of sugar cane varieties F108 and some others.** (Japanese with English résumé). Akira MORIYA. (J.J.G. 17, 1941, 62-64, 5 text-figs.).

The somatic chromosome number (root-tip cell? Reviewer) of 5 varieties of sugar cane varieties cultivated in Formosa was counted. It lies between 80 and 122. Chromosomes are illustrated.

**478. The number of chromosomes in some species and varieties of *Mentha*.** (Japanese with English résumé). Masato NAGAO. (J.S.S.A.F. 32, 1941, 28-36, 17 text-figs.).

The chromosome numbers in some species and varieties of the genus *Mentha* were counted, and the author has observed 24, 36, 46, 48, 49, 64, 68, 72, 84, 90 and 92. The root-tip cell nucleus of *Mentha arvensis* var. *vulgare* which is cultivated in Hokkaidô contains  $2n=64$ , with no exception, but quite different numbers are observed even in this species which is either wild or cultivated in other regions, thus, for example, in the Korean species  $2n=92$ , and in the Formosan one  $2n=90$ .

**479. Cytogenetics in the genus *Linum*.** Masato NAGAO. (J.J.G. 17, 1941, 109-116, 23 text-figs.).

Basing chiefly on the chromosome number the author has classified various species of the genus *Linum* into five groups, for which s. this JOURNAL 11, (103), No. 345. The cytological observations of the author concerning the species hybrid, *Linum perenne* and *alpinum* will be referred briefly below. This hybrid was first made up by KIKUCHI in 1929 and its  $F_1$  plants as well as their progenies are at present grown in Hokkaidô. In the  $F_1$  plants now under discussion the  $2n$ -number is 27, of which 9 are derived from *L. perenne* and 18 from *L. alpinum*. In the heterotypic metaphase of PMC many trivalents were met with, for instance, as  $7III+3II$ ,  $5III+5II+2I$ ,  $4III+16II+3I$  or  $2III+8II+5I$ , whence the author concludes that the genomic constitution of both parent species is homologous to each other. Further, it is not yet definitely determined, whether the conjugation of the chromosomes just indicated is that taking place between those coming from both parents or from either one of them, but the author tries to explain the formation of the genomes above indicated by the assumption of the autosyndesis between the non-homologous chromosomes in a genome.

**480. Iconographia plantarum Asiae Orientalis Vol. IV, No. 1.** Edited by Takenoshin NAKAI. (Tôkyô 1941, 305-336, 9 pls.).

The following plants are contained in this No.:

*Mitrastemon Kawasasakii* HAYATA (NAKAI), *M. cochinchinensis* NAKAI (NAKAI), *Symplocarpus nipponicus* MAKINO (NAKAI), *Aphyllorchis tanegashimensis* HAYATA (Y. KIMURA), *Ranunculus cuneifolius* MAX. (M. KITAGAWA), *Viola Tashiroi* MAKINO (T. TUYAMA), *Monotropastrum globosum* H. ANDRES (H. HARA), *Colysis pothifolia* H. ITÔ var. *multijugata* H. ITÔ (H. ITÔ), *Frullania nepalensis* (SPRENGEL) LEHMANN et LINDENBERG var. *nishiyamensis* S. HATTORI (S. HATTORI), *Chara Benthamii* AL. BRAUN (H. MORIOKA).

**481. Notulae ad plantas Asiae Orientalis (XV).** (With Japanese résumé). Takenoshin NAKAI. (J. Jap. B. 17, 1941, 1-17, 6 text-figs.).

The following plants, all from Corea, are described or enumerated: *Picea tonaisensis* NAKAI sp. nov., *P. koraiensis* NAKAI, *P. pungsanensis* UYEKI, *P. intercedens*

NAKAI sp. nov., *Betula cyclophylla* NAKAI, sp. nov., *Sparganium affine* SCHNITZLEIN, var. *zosteraefolium* HARTMAN, *Scheuchzeria palustris* L., *Sagittaria natans* PALLAS, *Chamaedaphne calyculata* (L.) MOENCH, *Andromeda polifolia* L. var. *grandiflora* LODDIGES, *Oxycoccus quadripetalus* GILBERT, *Vaccinium Vitis-Idaea* L., f. *minus* (LODDIGES) NAKAI, comb. nov., *Rubus Chamaemorus* L.

**482. Notulae ad plantas Asiae Orientalis (XVI).** (With Japanese résumé). Takenoshin NAKAI. (J. Jap. B. 17, 1941, 189-210, 1 text-fig.).

*Miyoshia Sakuraii* is the name made by MAKINO in 1903, who expressed the opinion that a new family *Miyoshiaceae* might be created for it. Thereafter this plant was transferred to either *Petrosavia* or *Protolirion*, and at present it is generally known by the name *Petrolirion Sakuraii* DANDY. Recent studies have however convinced the author of the fact that *Miyoshia* should be considered as a genus which is different from either *Petrolirion* or *Petrosavia*, and the name *Miyoshia Sakuraii* may be retained with full right. Further, the author has established for the genus *Miyoshia* a new family *Miyoshiaceae* and a new order *Miyoshiales* containing the latter. The genus *Miyoshia* contains at present two species *Miyoshia Sakuraii* MAKINO from Japan and *M. Sinii* (KRAUSE) NAKAI, comb. nov., from Kwangsi (China).

The following plants are noticed further in this No.: *Sorbus amurensis* KOEHNÉ var. *latifoliata* NAKAI, var. nov., *Utricularia intermedia* HAYNE, *Impatiens Textori* MIQUEL var. *atrosanguinea* NAKAI, var. nov., *Calpidisca Takenakai* NAKAI, sp. nov., (above four from Corea), *Canna indica* var. *a rubra* AITON, var. *flava* ROXBURGH, *Lespedeza melanantha* NAKAI, *Alnus traveculosa* HANDEL-MAZZETTI, *Costus speciosus* (KOEHNÉ) J. E. SMITH var. *leicalyx* (K. SCHUMANN) NAKAI, comb. nov., *C. formosanus* NAKAI, sp. nov., (*Costaceae* fam. nov.).

**483. Eriocapitella, a new genus proposed for Anemone vitifolia group.** (Japanese with Latin diagnoses). Takenoshin NAKAI. (J. Jap. B. 17, 1941, 263-272, 1 text-fig.).

The Japanese plant called "Kibunegiku" has been generally known by the name *Anemone japonica* SIEB. et ZUCC. But it was called in very various ways by various authors, for instance, *Atragene japonica* THUNB., *Clematis polypetalus* POIRET, *Anemone elegans* DECAISNE, etc., etc. The author has established for this plant and some others a new genus *Eriocapitella*. It contains the following species and varieties: *E. japonica* (THUNB.) NAKAI, comb. nov., *E. vitifolia* NAKAI, var. *Matsudai* NAKAI, comb. nov., var. *tomentosa* NAKAI, comb. nov., *E. elegans* NAKAI, comb. nov., f. *Honorine-Jobert* NAKAI, comb. nov.

**484. On Glyceria spiculosa ROSCHEWITZ, G. orientalis KOMAROV, G. debilior KUDO and G. lithuanica LINDMAN.** (Chiefly in Japanese). Takenoshin NAKAI. (J. Jap. B. 17, 1941, 325-331).

*Glycine lithuanica* (GORKI) LINDMAN, f. *viridescens* NAKAI, nom. nov., *G. spiculosa* (FR. SCHMIDT) ROSCHEWITZ are discussed. Synonyms are given.

**485. Carex viridissima has still its specific basis despite of Dr. OHWI's reduction to Carex Matsumurae.** (Japanese). Takenoshin NAKAI. (J. Jap. B. 17, 1941, 332-334).

Recently Dr. OHWI in his memoir on the classification of the genus *Carex* has united the species *Carex Taquetii* and *viridissima* into *C. Matsumurae* FRANCHET. Though the present author thinks the union of *C. Taquetii* with *C. Matsumurae* to be quite right, he cannot be in accordance with OHWI in respect to that of *C. viridissima* to *C. Matsumurae*, so that *C. viridissima* should stand independently as hitherto.



**486. The species of *Rhodochorton* from Japan I.** Yositeru NAKAMURA. (Sc.P., I.A.R., F.S., H.I.U. 2, 1941, 273-291, 17 text-figs. .

*Rhodochorton ryukyuense*, *R. sessile* and *R. Hyalosiphoniae* which are new species are described and illustrated among others.

**487. Ueber die Dispersion der Wiesenpflanzen.** (M. japan. Zfg.). Harufusa NAKANO. (B.M.T. 55, 1941, 281-287).

Die Dispersionsweise verschiedener Arten von zweierlei Wiesensoziationen aus tiefen Grasländern sowie Bergwiesen im Mitteljapan wurde untersucht. Beide Soziationen sind durch ihre respektive Dominanten charakterisiert, welche durch die Frequenzbestimmung festzustellen sind. Nach den Autorenstudien sind die Dominanten nicht immer normal dispergiert, ja sehr oft überdispergiert, während die sehr zerstreut vorkommenden Arten oft normal dispergiert sind.

Der Verf. kritisiert die "Konstanten" im neueren Sinne von DU RIETZ. Nach dem letzteren Autor sind die "Konstanten" diejenigen Arten, welche in der ganzen Variationsamplitude der Soziation regelmässig auftreten. Der Verf. sagt darüber, "wenn man die Konstanten von DU RIETZ... für die regelmässige auftretenden Arten hält, so wären sie nicht immer Dominanten. Hält man aber die Konstanten für die mit vor den anderen ausgezeichneten Frequenz begabten Arten, so wären sie mit hoher Abundanz begabten Arten oder mit Dominanten synonym. Jedenfalls ist das Wort Konstanten schwer verständlich und scheint deshalb in der Phytosoziologie nicht haltbar zu sein."

**488. Relation between the growth of the mycelium of *Cortinellus Shiitake* in pure culture and the kind of trees. I. Experimental results concerning the sawdust used as the culture base.** (Japanese). Y. NISIKADO, K. KIMURA and Y. MIYAWAKI. (A.S. 32, 1941, 409-441, 1 graph and 15 tables).

In order to study the question, what kind of trees will be preferable for the growth of the mycelium of *Cortinellus Shiitake* when its sawdust is employed as the base of pure culture, the authors have used in their experiments the sawdust of the trees from a number of plant families. The mycelia were observed to grow best on the sawdust of the three following tree species, viz. *Carpinus carpinoides*, *Platycarya strobilacea* and *Cornus controversa*, of which the woods are used generally in field culture of *Cortinellus Shiitake*. Several other kinds were found to be pretty good for the purpose, though inferior in comparison to the three species above pointed out. The sawdust of *Zelkova Keaki* and *Prunus donarium* var. *spontanea* were observed not to be suited for the purpose. The splint of chestnut tree was found to be suited for the purpose, but not its heart-wood.

The sawdust, of which the grains are about 1.5-3.0 mm. is good for the mycelial growth, but those smaller than above indicated are not. The sawdust mixed with water in the ratio 1:2 seems to be best for the purpose.

**489. Fundamental studies on the artificial propagation of *Armillaria Matsutake* II. On the pure culture and isolation of the mycelia of *Armillaria Matsutake*.** (Japanese). Yosikazu NISIKADO, Kitizi KIMURA and Yukio MIYAWAKI. (A.S. 32, 442-451, 3 pls. and 5 tables).—**Studies on the principles of growing Japanese Matutake artificially II. On the isolation of the mycelium of pure culture.** By the same authors. (B.O.I.L.F. 8, 1941, 443-453, 2 pls. and 5 tables).

Concerning *Armillaria Matsutake* ITO et IMAI, one of the most important edible mushrooms in Japan, NISIKADO and YAMAUTI have formerly got its pure culture start-

ing from its spore (cf. this JOURNAL 8, (70), No. 287, where one should read *Armillaria Matsutake* instead of misprinted *Armillaria Hatsutake*), but such culture was too weak to be used practically. In the present paper the authors have announced the results of their experiments in obtaining pure culture from the part of sporophore or from the soil with mycorrhiza. Pure cultures got in this way grow much more rapidly than those derived from the spore, and consequently they may be of practical use.

The authors' method of pure culture from the sporophore or mycorrhiza was briefly as follows:

The basal part of the stipe of the sporophore was cut off by a sterilized scalpel, immersed in 50% alcohol, sterilized with 0.1% corrosive sublimate, washed thoroughly with sterilized water, the excess of water being taken off by a filter-paper. The material was cut into several pieces and put in a Petri dish containing a certain agar medium (decoction of soil where the fungus is growing + 1% malt-extract + 2% agar, pH=3.5-4.27), and the whole was kept in an incubator at 24°C.

In the case of the isolation from the mycorrhiza in soil, the materials were directly placed in the acidified medium without any previous sterilization.

**490. Fortgesetzte Mitteilung über die Pilze, welche *Chaenomeles extus-coccinae* CARR. infizieren.** (Japanisch). Yosikazu NISIKADO und Yukio MIYAWAKI. (A.S. 32, 1941, 461-466, 4 Taf.).

Früher haben die Verff. einen Pilz erwähnt, welcher *Chaenomeles* infiziert (vgl. diesen JOURNAL 11, (24), Nr. 79). In der vorliegenden Mitteilung haben sie ferner zwei Arten Pilze erwähnt, nämlich, *Discosia Chaenomeles* und *Neottiospora Chaenomeles*, von denen beide neue Arten sind. Sie sind beschrieben mit Figuren.

**491. Notes on Japanese Musci. (IV).** (With Japanese résumé). Akira NOGUCHI. (J. Jap. B. 17, 1941, 211-225, 6 text-figs.).

*Archidium japonicum* BROTH., *Cryptodontopsis obtusifolia* NOGUCHI, comb. nov., var. *lasiensis* NOGUCHI, comb. nov., *Anacamptodon amblystegioipes* CARDOT, *A. latidens* BROTH., *A. japonicus* BROTH., var. *urceolatus* NOGUCHI comb. nov. Most of them are described in detail.

**492. Gramina japonica I.** (Chiefly in Japanese). Jisaburo OHWI. (A.PT.G. 10, 1941, 94-135).

The present paper is the review of the Japanese Gramineae with special reference to several modifications which have been taken place since the appearance of the HONDA's celebrated "Monographia Poacearum Japonicarum" in 1930. The following genera and tribes are treated.

Tribus Hordeae: *Brachypodium*, *Agropyrum*, *Elymus*, *Asperella*, *Hordeum*.  
—Tribus Leptureae: *Lepturus*.—Tribus Festuceae: *Bromus*, *Brylkinia*, *Festuca*, *Puccinellia*, *Poa*, *Dactylis*, *Glyceria*, *Melica*, *Schizachne*, *Diarrhena*.

The following are new species and provided with Latin diagnoses: *Agropyron chino-rossicum*, *Poa Tatewakiana*, *P. kanboensis*.

A number of new varieties are established.

**493. An account of the tribe Eragrosteae of Japan. I.** (With Japanese résumé). Jisaburo OHWI. (B.M.T. 55, 1941, 274-280).

In this first part the genus *Eragrostis* is treated of. The analytical key for the identification of the species is given. Among 16 species enumerated the following are new and described: *E. Fauriei* and *E. pilosiuscula*.

**494. On the detection method of growth-inhibiting substance.** (Japanese with English résumé). Yasuyuki OKABE. (B.M.T. 55, 1941, 187-194).

Some time ago the author has made the experiments on the behaviour of the growth-inhibiting substance present in the petiole of some plants. The method was to put its upper cut surface in agar block and to examine the positive curvature (cf. this JOURNAL 11, (110)-(111), Nos. 370-371).

Some further details in respect to the behaviour of the growth-inhibiting substance are noticed in the present paper with the use of the *Avena* method.

In the author's experiment the positive curvature of the coleoptile becomes larger, when the number of petioles put in contact with the agar block increases, or when the petiole segment becomes longer. The maximum curvature of the *Avena* coleoptile was attained after three hours, whilst one hour contact of the petiole with agar sufficed to get the maximum curvature of the *Avena* coleoptile. In the case of the petiole which contains a small amount of the inhibiting substance three hours are required to get the positive curvature which is larger than that observed in the blank control agar block, whilst that of the petiole containing a large amount of that substance only 21 hours were required to get the same effect.

**495. Intergeneric hybridizations in Cichorieae V. Variation in karyotypes and fertility in *Crepidiastrixeris denticulato-platyphylla*.** Humihiko ONO. (Cyt. 11, 1941, 338-352, 25 text-figs.).

The natural hybrids *Crepidiastrixeris denticulato-platyphylla* (parents, *Crepidiastrum platyphyllum* and *Paraixeris denticulata*) were studied by the author in genetical and cytological respects.

The number of florets per head is variable between 7-15 with the mode at 11. The fertility as determined by the ratio of the number of florets to that of ripe achenes was in minimum and maximum 27.69% and 77.27% respectively, the latter being found in the case of head with 11 florets. The number of the involucre is more stable than that of florets just indicated, varying between 6-8 per head.

In respect to the karyotypes the author has found one hypoploid form (9 chromosomes), one diploid-tetraploid chimera (10 and 20 chromosomes) and one tetraploid form (20 chromosomes).

As to the meiosis the pairing and separation of the chromosomes and the formation of tetravalents were often observed to proceed pretty regularly.

**496. Sex behaviour of triploid intersexes in *Humulus japonicus*.** (Japanese with English résumé). Tomowo ONO. (B.M.T. 55, 1941, 94-102, 4 text-figs.).

In the second generation of polyploids of *Humulus japonicus* induced by the colchicine treatment, the author has got the diploids and the triploids. The former are female while the latter are either female or intersex of various grades (i.e.  $\pm \sigma$ ,  $\varphi$  and  $\pm \varphi$ ). The karyotype analysis has revealed the triploids female to be of  $2n = XXX + 21a$ , the intersexes to be of  $2n = XYYY + 21a$ , the normal female and male being  $2n = XX + 14a$  and  $2n = XYY + 14a$  respectively, which agrees with what we see in *Rumex acetosa*.

The triploid intersexes are monoecious, the male and female flower clusters being on either the same or different branches. Male flower clusters are situated on the upper, and female ones on the lower branch of the stem. It is remarkable that the triploid intersexes start out as females and later change into males; the male flowers are always sterile, while the female ones are more or less fertile. (Cf. this JOURNAL 11, (67), No. 229).

**497. Periodizität der Mitosen in der Wurzelspitze verschiedener Kulturpflanzen.** (Japanisch m. deutsch. Zfg.). Kan'iti SAKAI. (J.J.G. 17, 1941, 35-40, 1 Abb. und 2 Tab.).

Für alle diejenigen, welche sich mit der Kernteilungsfrage beschäftigen, wird die Kenntnis, zu welcher Zeit die Kernteilungsbilder in irgend einem Organe am zahlreichsten vertreten sein wird, immer höchst willkommen sein, weil dadurch die Ersparnis sowohl der Arbeitszeit als der Untersuchungsmaterialien ermöglicht werden kann.

Der Verf., zusammen mit einer Gruppe von Studenten, hat zu verschiedenen Stunden bei der Wurzelspitze einer Anzahl von Kulturpflanzen die Fixierung nach der üblichen Methode ausgeführt und dabei die Kernteilungsvorgänge beobachtet. Die Resultate sind in zwei Tabellen zusammengestellt und in Kurven gezeichnet.

Unten werden einige Beispiele zitiert werden.

Bei der Reispflanze ist das Maximum der Kernteilung zu 2½ Uhr Tages und besonders zwischen 1½-3½ Uhr Nachts nachzuweisen, sodass dabei die zweimalige Periode pro 24 Stunden nachzuweisen ist. Viele andere Pflanzen sind ebenso wie bei Reispflanze durch die zweimalige Periodizität ausgezeichnet. Dagegen bei *Vicia Faba* ist nur eine einmalige Maximumperiode zu beobachten, und zwar zu 1½ Uhr Nachts. Bei Einkornweizen und Roggen ist die Periodizität der Mitosen nicht deutlich.

**498. Ueber die Ammoniak- und Nitrataufnahme bei *Aspergillus oryzae*, mit besonderer Rücksicht auf die Wirkung einiger Schwermetalle und Zuckerarten.** Tetsu SAKAMURA. (J.F.S., H.I.U. Ser. V, 1, 1941, 177-239, 51 Tabellen).

Es ist wohl bekannt, dass bei der Ammoniumnitrat-Kultur von *Aspergillus oryzae* der pH-Wert der Nährlösung während der Kultur sich bis auf 2,0 erniedrigt und dann wieder allmählich aufsteigt, eine merkwürdige Erscheinung, welche die pH-Umkehr genannt wird. In der vorliegenden Abhandlung sind hauptsächlich die Resultate der Verfs. Kulturversuche über die Einflüsse einiger Schwermetalle und Zuckerarten auf diese Erscheinung erläutert.

Unten werden einige dabei durch Experimente festgestellte tatsächliche Ergebnisse kurz erwähnt. Für die im Abschnitt "Besprechungen" erläuterten Diskussionen sei auf das Original verwiesen.

Die Standardlösung des Verfs. für die Kultur bestand aus  $\text{NH}_4\text{NO}_3$  (5 gr),  $\text{KH}_2\text{PO}_4$  (2,5 gr),  $\text{MgSO}_4$  (1,25 gr), Glukose (45 gr) in 1000 ccm umdestillierten Wasser. Zu dieser Lösung wurden in verschiedenen Versuchen die Schwermetalle (Fe, Zn, Mn, Cu) oder die Zuckerarten, wie Fruktose, Saccharose hinzugefügt, und das Verhalten des pH-Wertes wurde untersucht. Bei Ammoniumnitrat-Kultur (d.h. Gebrauch der Standardlösung) wurde es beobachtet, dass von Fe in relativ grosser Konzentration (z.B.  $2 \times 10^{-5}$  mol) und von Zn in relativ kleiner Konzentration ( $5 \times 10^{-6}$  mol) die pH-Umkehr herbeigeführt und von Cu ( $5 \times 10^{-6}$  mol) sie verhindert wird. Es sei bemerkt, dass die soeben erwähnte pH-Umkehr davon herrührt, dass unter den durch Hydrolyse von Ammoniumnitrat entstandenen Base- und Säure-Anteil der letztere in grösserer Menge aufgenommen wird als der erstere. Weiter ist es festgestellt, dass die Verwendung von Saccharose als die C-Quelle statt der Glukose in der Standardlösung zur gesteigerten Nitrataufnahme und somit zur pH-Umkehr führt.

Hinzugefügt werden muss, dass die pH-Umkehr oftmals von dem üppigen Wachstum des Pilzes begleitet wird.

Sowohl bei der Ammoniak-Kultur (Verwendung des Ammoniumsulfates statt des Ammoniumnitrates in der Standardlösung) als bei der Nitrat-Kultur (Verwendung



des Natriumnitrates statt des Ammoniumnitrates) hat die Vermehrung der Schwermetalle in notwendiger Menge das Pilzwachstum befördert, doch bei der pH-Umkehr besteht der merkwürdige Unterschied zwischen beiden Kulturen, indem dadurch bei der ersteren der pH-Wert erniedrigt und bei der letzteren erhöht wird. Ein anderer Unterschied zwischen beiden besteht darin, dass Zn von mässiger Konzentration (z.B.  $5 \times 10^{-6}$  mol) das Optimum für das Pilzwachstum darstellt, und zwar bei der Ammonium-Kultur, nicht aber bei der Nitrat-Kultur.

Ein weiteres Gegensatz zwischen beiden Kulturen ist, dass während bei der Nitrat-Kultur Saccharose das Pilzwachstum befördert und die pH-Steigerung beschleunigt, bei der Ammonium-Kultur eine solche Wirkung der Saccharose kaum nachzuweisen ist.

**499. Beobachtungen über japanische Moosflora XXIII-XXIV.** (Mit japan. Zfg.). Kyuichi SAKURAI. (B.M.T. 55, 1941, 1-16. 20 Figuren; 205-212, 13 Figuren).

Die japanischen Arten der Gattungen *Bartramidula*, *Philonotis* und *Fleischrobryum* sind hervorgehoben. *Fleischrobryum* 1 Art, *Bartramidula* 3 Arten, *Philonotis* 21 Arten, von denen *P. luteo-tapes* und *P. Iwasakii* neue Arten sind.

Weiter, *Dicranoloma curvuloma*, *Campylopus taiwanensis*, *Rhizogonium armatum*, *Trachypus scindifolius*, *Plagiothecium Shinii*, *Bryhnia nitida* sind als neue Arten ausführlich beschrieben.

**500. Ueber die Veränderung des Trockensubstanz- und Wassergehaltes durch Kurztagebehandlung bei *Impatiens Balsamina*.** (Japanisch m. deutsch. Zfg.). Masao SANO und Ryohei TAGUCHI. (B.M.T. 55, 1941, 131-139, 8 Tab.).

*Impatiens Balsamina* wurde der Kurztagebehandlung unterworfen (von 5 Uhr Nachmittag zu 9 Uhr Vormittag des nächsten Tages im Dunkeln).

Die Blütenperiodizität trat früher als bei der Kontrolle und zugleich wurde das spezifische Pulvergewicht (im KÖKETSUSchen Sinne) von Stamm und Wurzel (besonders der obere Teil der ersteren) erhöht. Diese Resultate zeigen, dass die Beschleunigung der Blütenperiode mit derselben der Substanzaufnahme verbunden ist.

Auch die Zunahme des Wassergehaltes bei der Blütenperiode wurde festgestellt.

**501. Eriocaulaceae.** (Japanese). Yosisuke SATAKE. (NAKAI & HONDA, Nova Flora Japonica No. 6, 1940). 88 pp, 2 plates, 4 maps and 40 text-figs.

Though the content of this work agrees perfectly with what the author has published in other place (cf. this JOURNAL 11, (114), No. 382), two extensive tables are specially appended in this work. In each of them are given concerning each of 34 species belonging to the subgenus *Trimeranthus* clear sketches of bract, calyx and petal of male and female flowers, capsule and seed from the latter; besides, the fact whether the receptacle is hairy or not, is shown for each species. Thanks to these tables, not only do we get at once the comparative view of all these features in these species, but the data will be extremely convenient for all those who want to identify them.

**502. Parmeliales (I).** (Japanese). Masami SATÔ. (NAKAI & HONDA, Nova Flora Japonica No. 5, 1939). 87 pp, 1 phototypic pl. and 25 figs.

In this part the plants belonging to a new suborder Parmelineae established by the author himself are treated. It contains two families, Anziaceae and Parmeliaceae. The former includes one genus *Anzia* with 7 species ranked under 3 sections. The

latter contains the genera *Cetraria* and *Parmeliopsis*. The first of these genera contains 30 species ranked under 2 sections and the second 3 species.

**503. Cladoniales (I).** Masami SATÔ. (NAKAI & HONDA, Nova Flora Japonica No. 7, 1941). 105 pp and 31 text-figs.

Three families of the order Cladoniales are treated in this work, viz., Baeomycetaceae, Stereocaulaceae and Cladoniaceae.

The first of these three families contains 2 genera, *Baeomyces* (7 species) and *Glossodium* (1 species), the second 3 genera, *Pilophoron* (3 species), *Pseudobaeomyces* (established by the author, 1 species), and *Stereocaulon* (23 species), and the third 2 genera, *Gymnoderma* (1 species) and *Cladonia*. In the latter genus, of which already 50 Japanese species are known, the species number tends to increase rapidly, so that the treatment of its species is here excluded to be treated in future.

**504. East Asiatic lichens (V).** (Japanese with Latin diagnoses). M. M. SATÔ. (J. Jap. B. 17, 1941, 246-350, 1 text-fig.).

*Stereocaulon pendulum* ASAHINA sp. nov., *Pseudobaeomyces pachycarpus* (MÜLL. ARG.) SATÔ, comb. nov., var. *stipitatus* SATÔ, nom. nov.

**505. Materials of the Formosan fungi (4).** (Japanese). Kanekichi SAWADA. (T.N.H.S.F. 31, 1941, 261-267 with notes for each species).

The following fungi are enumerated, as found in Formosa: *Lepiota Vittadini* (MOR.) FR., *Marasmius Sacchari* WAKK., *Entoloma prunuloides* FR., *Pholiota Aegerita* FR., *Pèronospora Crossostephis* SAW. nov. sp., *Phytophthora Leersiae* SAW. nov. sp.

**506. New or noteworthy algae from Izu.** Sôkiti SEGAWA. (Sc.P., I.A.R., F.S., H-I.U. 2, 1941, 251-271, 4 pls. and 13 text-figs.).

The following new species are described and illustrated: *Ectocarpus izuensis*, *Sphacelaria Yamadae*, *Contarinia Okamurae*, *Cruriopsis japonica*, *Chondrus Yamadae*, *Faucheia leptophylla*, *Halichrysis japonica*, *Neomonospora sericata*, *Myriogramme subdichotoma*.

**507. Systematic anatomy of the articulated corallines (III).** *Amphiroa aberrans* YENDO. (IV). *Amphiroa crassissima* YENDO. (V). *Amphiroa cretacea* (POSTELS et RUPRCHT) ENDLICHER. (Japanese with English résumé). Sôkiti SEGAWA. (J. Jap. B. 17, 1941, 164-174, 4 text-figs.; 226-233, 4 text-figs.; 348-355, 4 text-figs.).

All three species of *Amphiroa* above cited, viz., *aberrans*, *crassissima* and *cretacea* are structurally in accord in various respects. Thus, for instance, the apical meristem layer is not covered by "Deckzellen", the central strand is made up of straight filaments composed of equally long cells, the boundary between the medulla and the cortex is not at all distinct, the node is made of a single zone of long cells, etc.

The situation of the conceptacle in the frond is either lateral or subterminal (in *A. aberrans*), lateral (in *A. cretacea*), neither marginal nor subterminal (in *A. crassissima*), the lateral and the marginal conceptacles taking their origin from the cortex, and the bottom of the subterminal being derived from the medulla.

No sexual individuals of *A. crassissima* were observed by the author, so that the following description refers exclusively to two other species.

In respect to sexual conceptacles the male one is conical and very prominently developed on the surface of the internode, and the spermatangia are produced, not only from the bottom, but also from the lateral side of the concave conceptacle cavity.

The female conceptacle which is hemispherical cone-shaped is also very prominent. The procarp is made up of a basal cell, a carpogonial branch and 1-2 undivided cells. In *A. aberrans* the gonimoblast filaments were seen to arise only from the periphery of the fusion cell, but it was not observed in *A. cretacea*. The spermatangia are produced, not only from the bottom, but also from the lateral side of the conceptacle cavity. The sporangia originate from the whole part of the bottom.

**508. Note on the archegonium of *Tsuga diversifolia* MAST.** (Japanese). Tamaki SHIMAMURA. (B.Z. 9, 1941, 57-60, 4 text-figs.).

The fertilization of *Tsuga diversifolia* which occurs in one and the same year as the pollination was observed by the author to take place in the beginning of July.

The ventral canal cell does not disorganize soon after its formation, as it is the case in many Conifers, but it remains till the time of fertilization without making any growth from the beginning.

The number of archegonia in one ovule is generally 5, rarely 8.

The author has observed the anomalous case, where two endosperms are produced in one ovule, and fuse to each other. The occurrence of 8 archegonia above indicated might be due to such anomalous process.

**509. Karyological studies in *Sacchromyces cerevisiae*.** Yosito SINOTÔ and Akira YUASA. (Cyt. 11, 1941, 467-472, 34 text-figs.).

The nucleus of *Saccharomyces cerevisiae* was studied and various methods used by the authors in these observations are announced in detail: fixing, staining in usual way, certain ferments, such as takadiastase, pepsin or trypsin were used to remove various granules in the cell-body.

The nucleus of the vegetative cells consists of a central karyosome surrounded by a hyaline zone and the external membrane. The karyosome is spherical or irregular in shape. It is homogeneous and deeply stainable: it behaves positively towards FEULGEN's nuclear reaction.

The nucleus divides through mitosis, during which 4 chromosomes appear in shape of thick threads. It divides in the spindle and form two daughter nuclei. One of the latter remains in the mother-cell, but another passes through the isthmus in order to travel to the daughter-cell, and at that time it takes the dumb-bell shape apparently, as it were dividing amitotically, which no doubt has led certain authors to the erroneous assumption of the occurrence of amitosis in yeast.

**510. On the starch pollen.** (Japanese with English résumé)- Makoto SISA. (B.S.A., T.I.U. No. 2, 1941, 24-41, 6 text-figs.).

The pollen grains contain either starch or oil as their reserve materials. The present paper refers to the former, i.e. starch pollen. The quantity of starch grains contained in pollen grains is different in different grains, and the author distinguishes 5 kinds, viz. full, abundant, scattered, few and nothing.

In some plants young pollen grains are filled up with starch grains, which however gradually diminish in the course of their growth, and disappear wholly or partially at the time of their maturation (A- and B-type). In other plants both young and mature pollen grains contain many starch grains, and no disappearance of them is recognizable at the maturation (C-type). In still other plants young pollen grains contain no starch grains at all, but they gradually increase and attain the maximum at the pollen maturation.

For accounting for the disappearance of starch grains in pollen the temperature and the moisture must be taken into consideration, inasmuch as the high temperature and the two extremes of air moisture (dry and wet) will lead to the rapid disappearance of starch grains.

A relation is recognizable between the germination of pollen and the disappearance of pollen starch grains, because in A-type, for instance, this process will not occur, unless the starch grains wholly disappear.

Though the young pollen which is filled up with starch grains will not germinate, they may be induced to germination by adding diastase to the nutrient medium of pollen grains.

**511. Untersuchungen über den Ascorbinsäuregehalt verschiedener Apfelsorten.** Tomota SUGAWARA. (Jap. J. B. **11**, 1941, 327-341, mit 1 Textfig. und 4 Tab.).

**512. Studies on the formation of ascorbic acid (vitamin C) in plants 4. Daily variation of ascorbic acid content and the concentration of carbohydrate in the leaves of plants.** Tomota SUGAWARA. (Jap. J. B. **11**, 1941, 343-356, with 5 text-figs. and 5 tables).

**513. The embryogeny of *Cunninghamia lanceolata* HOOKER.** Yosinori SUGIHARA. (Sc. Rpts., T.I.U. **16**, 1941, 187-192, 2 pls. and 2 text-figs.).

The embryogeny of *Cunninghamia lanceolata* has been studied long ago by MIYAKE in respect to the comparatively early stages of development. The present paper is chiefly devoted to the publication of the results of the author's studies in this plant in respect to the stages following those studied by MIYAKE.

After fertilization the fusion nucleus undergoes three successive simultaneous divisions, so as to give rise to eight free nuclei, after which the cell-wall formation soon occurs. The cells thus produced are arranged at first in two, and soon afterwards in three tiers. The cells of the uppermost tier are open towards the archegonial cavity. Those of the second tier develop into the prosuspensor, which elongates enormously and tortuously, while those of the third tier represent the embryonic cells. The latter divide repeatedly to form a small cell-mass. Among 4-8 embryonic cells in this cell-mass, which are placed at the tip of the prosuspensor one or two become quite empty, forming so-called cap-cells. Each of the remaining embryonic cells divides several times, and soon after the cells lying next to the prosuspensor elongate in tortuous manner to form the so-called primary suspensor. Each of the embryonic cells at the apex of the latter then divides to form a group of embryonic cells. Those situated next to the primary suspensor later differentiate into embryonal tubes, and thus finally the dicotyledonous embryo is developed. In this plant cleavage polyembryony thus takes place twice, firstly at the tip of the prosuspensor, and secondly at that of the primary suspensor.

The author remarks that the coexistence of cleavage polyembryony and the cap-cells in one and the same species is exceptionally observed among the Conifers, viz. simply in *Sciadopitys* and *Cunninghamia*.

The haploid chromosome number in this plant, as observed in the metaphase of PMC was found to be 11 instead of 12, as announced by MIYAKE.

**514. A list of chromosome numbers in angiospermous plants VII.** Teranosuke SUGIURA. (P.I.A. **17**, 1941, 29-30).



The chromosome numbers in 43 plant species belonging to 8 families is shown in a list. Especially in *Campanula* 13 species are studied, the n-number lying between 8 (*C. subpyrenaica*) and 34 (*C. caespitosa* and *Hostii*).

**515. Influence of physical and chemical factors upon the formation of appresoria in the conidia of *Piricularia Oryzae* II. Influence of temperature.** Hashio SUZUKI. (Jap. J. B. **11**, 1941, 357-376, with 2 pls. and 7 text-figs. and 6 tables).

**516. Ecological studies of peat bog IV. *Sphagnum* species on Mt. Hakkôda.** (Japanese). Hyôzi SUZUKI. (E.R. **7**, 1941, 8-18, 3 text-figs.).

In Mt. Hakkôda there are a number of peat bogs of various size. The author has collected there the following species of *Sphagnum*: *S. fimbriatum* WILSON, *S. acutifolium* EHRHART, *S. Girgensohnii* RUSSOW, *S. squarrosum* PERSON, *S. teres* (SCHPR.) ANGSTROEM, *S. recurvum* PALISOT DE BEAUVOIS, *S. tenellum* (EHRH.) LINDBERG, *S. subsecundum* NEES, *S. Takedae* SH. OKAMURA, *S. hakkodense* WARNSTORF et CARDOT, *S. palustre* L., *S. magellanicum* BRIDDEL. Their distribution in various peat bogs are noticed.

The author concludes that in peat bogs situated near each other, the *Sphagnum* species growing there are allied systematically.

**517. *Lycopodium subinundatum* TAGAWA, a new species from Japan.** (In Japanese with Latin diagnosis). Motozi TAGAWA. (A.P.T.G. **10**, 1941, 74-75).

**518. Further studies of the conceptacle development of *Sargassum*.** Masato TAHARA. (Sc. Rpts., T.I.U. **16**, 1941, 10 figs.).

Some time ago, the author, in studying the conceptacle development in some species of *Sargassum*, has observed that the tongue-cell derived from the initial cell by division becomes free from the wall of the conceptacle and is transferred to its opening to close it up completely (cf. this JOURNAL **11**, (73), No. 248). In the present study he has observed the conceptacle development in 11 species of *Sargassum* belonging to several subgenera. Just the same behaviour of the tongue-cell was confirmed in several species belonging to the subgenus *Bactrophycus*, viz. *S. hemiphyllum*, *tortile*, *confusum*, *Ringgoldianum*, *sagamianum*, *Thunbergii* and *fusiforme*. In some other species, viz. *S. pilulifera* (subgenus *Phyllotricha*), *patens* (subgenus *Schizophycus*), *duplicatum* (subgenus *Eusargassum*), on the contrary, the tongue-cell undergoes the degeneration in early stage of the conceptacle development and remains attached to its wall. *S. filipendula* in which SIMONS did not see the translocation of the tongue-cell to the conceptacle opening, belongs to the subgenus *Eusargassum*.

**519. Embryogeny of *Podocarpus macrophyllus* and *Podocarpus Nagi*.** Masato TAHARA. (S. Rpts., T.I.U. **16**, 1941, 91-98, 2 pls. and 12 text-figs.).

In *Podocarpus macrophyllus*  $n=19$  (PMC) and  $2n=38$  (root-tip cell).

Fertilization takes place in the middle of July. In the pollen tube penetrating into the nucellus a number of free nuclei are visible, but the body-cell is easily distinguishable on account of the division of its nucleus into two sperm-nuclei, of which the non-functional is naked and smaller than the other. After fertilization three successive divisions of the fusion nucleus give rise to 16-nucleate embryo-sac, and the cell-wall formation sets in soon after. The proembryo is made up of either two or three tiers. The terminal tier is commonly represented by a single tip-cell containing

two free nuclei. The second tier elongates to form the suspensor, and an embryo is formed at its end. Not rarely the cells constituting the suspensor become separated and produce an embryo at the end of each single-celled suspensor (cleavage polyembryony).

In certain cases the rosette tier is developed in the second tier.

In respect to the embryogeny of *Podocarpus Nagi* cf. this JOURNAL **11**, (119), No. 400.

**520. Further reports of cytological and genetical investigations of *Rumex acetosa* L. IV. On the offspring of a diploid intersexual plant containing chromosome fragments.** Yo TAKENAKA. (J.J.G. **17**, 1941, 28-31, 4 text-figs.).

The author has got some diploid, intersexual, male or female plants of *Rumex acetosa* with chromosome fragments in their genome, thus, for example,  $12a+2X+1f$  ( $f$ =fragment) (female),  $12a+X+2Y+2f$  (male),  $12a+X+2Y+7f$  (intersexual), etc., etc. The author thinks that in the male intersexual plants used in his observations the chromosome fragments have no influence at all upon the sex-determination, which might be worked out by certain genes in the autosomes. In one and the same individual the number of chromosome fragments is very variable. The cause of this phenomenon the author tries to explain in various ways.

**521. Chromosome studies in Cyperaceae XI. Pollen development in five genera with special reference to *Rhynchospora*.** (With Japanese résumé). Nobunori TANAKA. (B.M.T. **55**, 1941, 55-65, 1 pl., 29 text-figs. and 1 table).

It is well known in Cyperaceae that among four nuclei of each pollen mother cell three degenerate and only one remains to form the vegetative and the generative nucleus. Three nuclei which go into degeneration are those situated at the innermost region of pollen mother cells radially arranged in the pollen-sac, i.e. the apical region of the wedge-shaped pollen mother cell, whence the author calls them "apical cells."

The author has published in the present paper the results of his studies concerning the pollen development in five genera of the Cyperaceae, viz. *Bulbostylis barbata* ( $n=5$ ), *Sclera tessellata* ( $n=14$ ), *Kyllingia brevifolia* var. *leiolepis* ( $n=60$ ), *Cyperus sanguinolensis* ( $n=21$ ), and *Rhynchospora japonica* ( $n=31$ ). In the four former species the degeneration of three nuclei has taken place in usual way, i.e. three apical nuclei have degenerated, either with or without undergoing the division. The behaviour of pollen development in *Rhynchospora japonica* was observed to be unique, inasmuch as three basal nuclei, i.e. those situated at the outermost region of each pollen mother cell corresponding to the basal part of the wedge-shaped mother cell, have undergone the degeneration, in sharp contrast to what we see in other genera. The septum formation has taken place between the region of three degenerated nuclei and that of the surviving nucleus.

It was observed some time ago by certain authors that in the Juncaceae the three nuclei situated at the basal region ("Basalkerne") are separated from the pollen nucleus ("Spitzenkern") by a septum just as in *Rhynchospora* and that they divide then simultaneously, though the further development of such divided basal nuclei had been yet never observed. The above fact might, as the author thinks, point out towards the phylogenetic relationship between the Cyperaceae and the Juncaceae.

**522. Chromosome studies in Cyperaceae XV. Aneuploid plant of *Carex macroglossa* FR. et SAV. and *C. parviflora* BOOTT.** (Japanese with English résumé). Nobunori TANAKA. (B.M.T. **55**, 1941, 218-225, 12 text-figs.).

Each of the two *Carex* species, viz. *C. macroglossa* and *parciflora* is distinguished by its intra-specific aneuploidy. The chromosome number in PMC of *C. macroglossa* is 23, 24 or 25, while that in *C. parciflora* is 19, 20 or 22. The meiosis in PMCs is quite regular in both species. They belong to the Section Paniceae and are regarded as secondarily balanced types. The author thinks that the aneuploidy just indicated might be due to the cooperation of  $b=6$  in the Section Siderostictae and  $b=9$  in the Section Montanae.

**523. The genus *Hypnea* from Japan.** Takesi TANAKA. (S.P., I.A.R., F.S., H.I.U. 2, 1941, 227-250, 2 pls. and 21 text-figs.).

In the classification of Japanese species of *Hypnea*, the author has taken into consideration, besides outer features, also inner characters, especially concerning the central axis of the frond as well as lenticular thickenings of medullary cells. 14 species are enumerated, among which *H. Boergesenii* and *H. japonica* are new species.

**524. Forest flora of the Island of Etorohu, South Kuriles.** (Japanese with English résumé). Misao TATEWAKI. (E.R. 7, 1941, 1-7, 1 text-fig.).

Trees and shrubs seen by the author in the Island Etorohu, South Kuriles (i.e. 20 species trees and 80 species small trees and shrubs, in total 100 species belonging to 3 families and 61 genera) are enumerated. Various kinds of forests were met with, viz. those of *Abies sachalinensis*, *Larix Gmelini*, *Pinus pumila*, *Salix sachalinensis*, *Alnus hirsuta*, *Quercus crispula*, *Betula Ermanni*, and *Alnus Maximowiczii*.

An important feature concerning the plant distribution is that trees and shrubs growing in Etorohu are systematically much more allied to those in the neighbouring Kunasiri Island (south) and Hokkaidô rather than to those in Middle and North Kuriles. This remarkable fact clearly indicates, according to the author, that in ancient times no southward transition of trees through the row of islands of the Kuriles as stepping stones had taken place, but that the floral elements of the Continent and Honsyû came here through Hokkaidô.

**525. Zytologische Untersuchungen über die Lebermoose von Japan.** Seizi TATUNO. (J.S., H.U. 4, 1941, 73-187, 2 Taf. (Mikrophotographien) und 100 Textfig.).

Die vorliegende Abhandlung ist hauptsächlich eine Zusammenstellung von zahlreichen vom Jahre 1933 an vom Verf. vorläufig veröffentlichten Arbeiten über die Chromosomenverhältnisse der japanischen Lebermoose, welche im ganzen sich auf 101 Arten und 2 Varietäten beziehen.

Unten werden die allgemeinen Schlüsse der Verfs. Untersuchungen kurz referiert.

Bei gemischtgeschlechtigen Lebermoosen, z.B. *Plagiochasma reboulloides*, *nipponica* und *intermedium* kann man ihren Karyotypus als  $4V+3J+1+m$  bezeichnen, wobei V ein grosses, V-förmiges, J und j je ein nächstgrösses J- bzw. j-förmiges, und m ein kleinstes stäbchenförmiges Chromosom des betreffenden Chromosomensatzes darstellt. Obgleich diese drei *Plagiochasma*-Arten ihrem Karyotypus nach völlig zueinander übereinstimmen, sind ihr Verhalten in bezug auf die Heteropyknose ganz verschieden. Bei *P. intermedium* und *nipponica*, nämlich, erkennt man gar keine Heteropyknose, aber in *P. reboulloides* ist in der Interphase und Prophase die Heteropyknose (total oder partiell) bei 1 V- und m-Chromosom deutlich zu beobachten. In diesen und anderen ähnlichen Fällen nennt der Verf. das grösste V-förmige und das kleinste stäbchenförmige Chromosom das H- bzw. h-Chromosom.

Bei 19 getrenntgeschlechtigen Arten hat der Verf. die Geschlechtschromosomen nachweisen können. Dabei beträgt die Zahl der Autosomen 7, 8 oder 9 und die

Geschlechtschromosomen sind nach dem üblichen Gebrauch als X (♀) und Y (♂) bezeichnet. So z.B. bei *Conocephalus supradecompositus* ♀ 8+X, ♂ 8+Y. X und Y sind dadurch ausgezeichnet, dass jedes desselben hyperchromatisch, und besonders in der Inter- und Prophase heteropyknotisch ist. In den *Frullania*-Arten aus der Untergattung *Galeiloba* hat man ♀ 7+X<sub>1</sub>+X<sub>2</sub>, ♂ 7+Y, d.h. bei ♀ gibt es zwei heteropyknotische Chromosomen, von denen X<sub>2</sub> etwas kleiner und doch keineswegs das kleinste Chromosom des betreffenden Chromosomensatzes ist und Y in Grösse intermediär zwischen X<sub>1</sub> und X<sub>2</sub> liegt.

Nach der Verfs. Ansicht sind die Geschlechtschromosomen phylogenetisch aus H- und h-Chromosomen abzuleiten und zwar müssten dieselben von *Conocephalus supradecompositus*, *Marchantia polymorpha* und *diptera* und *Pellia Fabbriana* von h, und dieselben aller vom Verf. untersuchten übrigen Arten aus H hervorgekommen sein, wie man nach der Grösse und Gestalt der betreffenden Chromosomen beurteilen kann.

Zum Ende möchte der Ref. eine kleine Bemerkung machen. Nach den Verfs. Untersuchungen bei den *Frullania*-Arten aus der Untergattung *Thyopsiella* (z.B. *Fr. moniliata*), sind bei beiden ♀- und ♂-Gametophyten je zwei heteropyknotische Chromosomen H und h vorhanden. D.h. der Karyotypus ist sowohl bei ♀- als bei ♂-Gametophyt 7+H+h, sodass in dieser Hinsicht man zwischen beiden gar keinen Unterschied erkennen kann. Die Frage wird sein, welches Chromosom, H oder h, im ♂-Gametophyt man für Y nehmen muss.

**526. Studies on the osmotic concentration and NaCl content of some seashore plants.** (Japanese with English résumé). Michio TSUDA. (B.M.T. 55, 1941, 226-234, 2 text-figs. and 1 table).

The osmotic concentration and NaCl content of seven plants growing in sandy shore of Kugenuma, Kanagawa Prefecture, were determined in respect to the sap extracted from their respective leaves by means of cryoscopic method. The results are shown in a table. The inspection of this table shows that *Carex Kobomugi* OHWI and *C. pumila* THUNB. are distinguished by their highest osmotic concentration from other plants which were studied, thus, for instance, *C. Kobomugi*, osmotic value 14-15

(atm), NaCl content 7 (atm),  $\frac{\text{NaCl content}}{\text{osmotic value}} = 46-47\%$ , water content of leaves 69%.

When such values will be compared to those determined in the halophytes, as *Salicornia*, *Suaeda*, etc. they are seen to be much lower, whence the author concludes that the plants studied by him are very weak in their halophytic characteristics.

**527. On genus *Melampyrum* of Japan.** (Japanese with Latin diagnoses). Takasi TUYAMA. (J. Jap. B. 17, 1941, 77-95).

Among 9 species of *Melampyrum* enumerated the following new species is described: *M. yakusimense* TUYAMA sp. nov.

**528. Genetic and cytological studies of speltoid wheat II. Origin of speltoid wheat.** Isamu UCHIKAWA. (M.C.A., K.I.U. No. 50, 1941, 96 text-figs.).

The author has studied the genetics and cytology of three series of speltoid wheats, called A, B and C, which are distinguished from one another by their respective segregation mode.

*A-series*.—Self-pollination of this type of speltoid wheat gives rise to normals: heterozygotic speltoids: homozygotic speltoids in 1:2:1 ratio, and the chromosome number is  $2n=42$  in each of them. In PMC 21II are observed with few exceptions. The origin of this series of speltoid wheat from the normal (*Triticum vulgare*) is explained



as follows. The genom of normal wheat contains three kinds of chromosomes A, B and C: A carries the genes of normal wheat character, B those for speltoid and awned character, which are absolutely linked together, while C possesses the inhibitors for the two latter characters. The speltoid wheat of A-series should have originated owing to the simultaneous mutation of the inhibitors borne in C-chromosome to recessive condition, whereupon the zygotes  $1 \frac{ABC}{ABC}$  (normal:  $2 \frac{ABC}{ABc}$  (heterozygotic speltoids):  $1 \frac{ABc}{ABc}$  (homozygotic speltoids)) will be segregated out as the consequence of self-pollination (c being the chromosome carrying recessive genes).

**B-series.**—The segregation takes place in the ratio, normal: heterozygotic speltoid: homozygotic speltoid=1: 4.5: 0.05 (with some few other forms), and their chromosome number is 42, 41 and 40 respectively. The origin of this series of speltoid wheat is attributed by the author to the mutative elimination of C-chromosome, so that normal  $\frac{ABC}{ABC}$   $2n=42$ , hetero. speltoids  $\frac{AB}{ABC}$   $2n=41$ , and homo. speltoids  $\frac{AB}{AB}$   $2n=40$ . In this case the random mating between the gametes possessing 21 and 20 chromosomes should give rise to normals, hetero-speltoids and homo-speltoids in 1:2:1 ratio, which is quite different from the observed ratio above indicated. This difference is explained by the two hypotheses, (1) the certation between the pollen grains containing 21(ABC) and 20 chromosomes (AB), in which those of the former kind act far more effectively than those of the latter (often 20 times more effectively), and (2) the elimination of a certain number of homozygotic speltoids,

**C-series.**—The segregation ratio is normal: hetero-speltoid: homo-speltoid=1:1.1:0.1, and the chromosome number  $2n$  is equally 42 in all three. The origin of this series is attributed to the fragmentation of C-chromosome into two pieces  $S_1$  and  $S_2$ , so that normal  $\frac{ABC}{ABC}$ , hetero-speltoid  $\frac{ABS_1}{ABC}$  (or  $\frac{ABS_2}{ABC}$ ), and hetero-speltoid  $\frac{ABS_1}{ABS_1}$  (or  $\frac{ABS_2}{ABS_2}$ ) are segregated out. The free mating should give rise them to the ratio 1:2:1, and the difference between the theoretical and the observed ratio is explained just as in the case of B-series by the hypotheses, (1) the certation between the normal (ABC) and the speltoid  $\sigma$  gametes ( $ABS_1$ ), in which the former kind of gametes will act far more effectively than those of the latter (e.g. 10 times more effective), and (2) the elimination of a certain number of homozygotic speltoid zygotes.

**529. On the northern limit of broad-leaved evergreens in Korea.** (Japanese). Hidemiki UYEKI. (A.PT.G. 10, 1941, 89-93, 1 text-fig. and 2 tables).

Some time ago the author has announced that the northern limit of broad-leaved evergreens in Korea lies at  $35^\circ$  N-latitude. Later studies have however revealed that that limit passes northwards beyond into  $35^\circ 37'$ , which is the Henzen Peninsula situated in western coast of Korea. The author's conclusions on its floral distribution are briefly as follows.

The number of broad-leaved evergreens in this region is 12. They are almost all shrubs and rarely trees, which, however, are dwarfed. That region may be considered as the northern limit of broad-leaved evergreens in Korea.

Among broad-leaved deciduous trees in this region plants of warm region are growing, as *Idesia polycarpa*, *Ligustrum ovalifolium*, *Caesalpinia sepiaria* var. *japonica*, *Symplocos Tanakana*, *Mallotus japonicus*, *Cymbidium virescens*, *Ophiopogon japonicus*, and the region may also be considered as the northern limit of broad-leaved

deciduous plants of warm temperate zone. In this respect it may be remarked that sweet potatoes and native cottons are cultivated here and esteemed as plants best suited to the region.

**530. Ueber die Spindelfigur bei der somatischen Mitose der Prothalliumzellen von *Osmunda japonica* THUNB. in vivo.** Bungo WADA. (Cyt. 11, 1941, 353-368, 251 Textfig.).

Dieser Aufsatz betrifft die Lebendbeobachtung der Mitose bei den jungen Prothalliumzellen von *Osmunda regalis*. Das wichtigste Resultat der Verfs. Untersuchungen, an welchem ein grosses Gewicht gelegt wird, ist die Tatsache, dass im Gegensatz zu den bisher gewöhnlich ausgesprochenen Ansicht, "weder das Verschwinden der Kernwandung am Ende der Prophase noch das Vermischungsvermögen der Kernflüssigkeit mit dem Zytoplasma beim Auftreten der Metaphasespindel stattfinden, dass sich die Wandung des Prophasekernes dabei kontinuierlich zu derjenigen des Atraktosoms und weiter zu derjenigen des Phragmoplasten verändert, und dass sich das als Grundsubstanz der achromatischen Figur aus der Karyolymphe entstandene Atraktoplasma hinsichtlich seiner Gestalt und seiner Funktion vom Zytoplasma sich abgrenzend als ein abgeschlossener Körper verhält."

Bezüglich der Scheidewandbildung, "entwickelt sich ihre Anlage im Phragmoplasten zentrifugal, die feste Scheidewand jedoch durch Mitwirkung des Zytoplasma-wandbelags der Mutterzelle zentripetal, wobei die Scheidewandbildung... von der einen Seite der Mutterzellwand zu einer anderen fortschreitet."

Nach der Bildung der Zellplatte zytomatisiert sich die Phragmoplastensubstanz, welche an der Scheidewandanlagebildung nicht beteiligt war, der ganze Phragmoplast degeneriert sich.

**531. Notes on the crystals in the leaves of saxifragaceous plants (I)-(II).** (Japanese). Shunji WATARI. (B.Z. 9, 1941, 479-488, 639-645, 37 text-figs.).

The author describes in the present paper the results of his observations concerning the crystals in the leaves of almost 60 genera belonging to the Saxifragaceae in somewhat broad sense, such as adopted by ENGLER.

Monoclinic crystals in the Saxifragaceae are solitary, stellate, needle-shaped (raphides), rarely spherocrystals or even the bundles of the latter, or crystal sand. Stellate crystals are mostly prevalent, generally one in each cell, rarely more than two (for instance, the subfamilies Penthorideae, Saxifragoideae, Iteoidae, etc.); often both stellate and solitary crystals are found in one and the same plant. Cells containing crystals are generally solitary, but often have the tendency to form the group, which is especially conspicuous in the mesophyll of the species of *Mitella* and in the mesophyll and midrib of *Francoa*. In *Kirengeshoma* solitary crystals are present exclusively, and in two species belonging to the Section Diptera of *Saxifraga* the raphides are seen exclusively. The raphide-bundles are observed, not only in *Hydrangea*, as formerly assumed, but also in *Rodgersia* and *Astilboidea*.

In petioles, though crystals may be present throughout the whole length uniformly, they are most commonly abundant in their apical and basal portion. In nerves they are either present or absent. Also in respect to vascular bundles they are present in the endodermis, phloem parenchyma, or in the parenchyma near the protophloem.

In the mesophyll they are generally present in the transitional part of the palisade and spongy parenchyma, sometimes exclusively in that part, or sometimes besides that either in palisade or spongy parenchyma.

For all other details in the paper cf. the original.

**532. The behaviour of tetravalent chromosomes and its bearing on sterility in *Aegilops Heldreichii* × *Ae. comosa* and its offspring.** (Japanese with English résumé). Ihei YAMADA and Eitaro SUZUKI. (J.J.G. 17, 1941, 83-96, 5 text-figs. and 8 tables).

In  $F_1$  hybrids between *Aegilops Heldreichii* and *Ae. comosa*, in each of which the n-chromosome number is 7, the authors have observed in the I-metaphase of PMC mostly the genom  $1IV+5II$ , though sometimes  $7II$  or  $1III+5II+1I$  was met with. The tetravalent just indicated was either N- or U-shaped. In  $F_2$  or  $F_3$  both chromosome types, i.e.  $7II$  and  $1IV+5II$  were segregated out in the ratio 1:1.

In the N-shaped tetravalent adjacent chromosomes, in separating at the metaphase, go to opposite poles, thus a regular disjunction of chromosomes takes place. In the U-shaped tetravalents, however, where adjacent chromosomes go to the same pole, deficiency and duplication of chromosome segments are the results, so as to lead to the anomalous disjunction.

In  $F_2$ - and  $F_3$ -plants containing  $7II$  the regular disjunction of chromosomes is observed, and the number of good pollen grains amounts to 90%. In  $F_1$ -,  $F_2$ - and  $F_3$ -plants having the tetravalents, the amount of regular disjunction and that of good pollen grains are each sometimes more than 75%. Thus it will be seen that the number of regular disjunction and the fertility of pollen grains are in close correlation.

The fertility of the ovules in the plant having the tetravalents was more than 80%, i.e. somewhat higher than in the case of pollen grains. In  $F_2$  and  $F_3$  having  $7II$ , that fertility was 90%, just as in the case of pollen grains.

On the basis of their observations the authors think that the tetravalent complex just cited is the result of a simple translocation. Further, they think that the types of chromosome disjunction are mainly attributable to the repulsion between the homologous chromosome segments.

**533. Notes on some Japanese algae IX.** Yukio YAMADA. (Sc.P., I.A.R., F.S., H.I.U. 2, 1941, 195-215, 9 pls. and 14 text-figs.).

In the present paper the following algae are treated. Many of them are described, and all are fully illustrated: *Chaetomorpha pachynema* MONTAGNE, *Sphacelaria furcigera* var. *tenuis* YAMADA var. nov., *Callophyllis hayamensis* YAMADA sp. nov., *Callymenia origonema* YAMADA sp. nov., *Cryptonemia Yendoi* WEBER VAN BOSSE, *Cryptopleura hayamensis* YAMADA sp. nov., *Gelidium Kintaro* (OKAM.) YAMADA nom. nov., *Gloioderma iyoensis* OKAMURA, *Gracilaria coronopifolia*, J. AGARDH, *G. punctata* (OKAM.) YAMADA comb. nov., *G. purpurascens* J. AGARDH f. *spinulosa* (OKAM.) YAMADA, comb. nov., *Grateloupia turuturu* YAMADA sp. nov., *Halachnion parvum* YAMADA sp. nov., *Helminthocladia macrocephala* YAMADA sp. nov., *Hypoglossum sagamianum* YAMADA sp. nov., *Liagora boninensis* YAMADA sp. nov., *Lophocladia japonica* YAMADA sp. nov., *Myriogramme ciliata* YAMADA sp. nov., *Nemastoma foliacea* YAMADA sp. nov., *Rhodymenia parva* YAMADA sp. nov., *Symphocladus latiuscula* YAMADA comb. nov.

**534. On the culture experiment of *Monostroma zostericola* and *Enteromorpha nana* var. *minima*.** Yukio YAMADA and Tiyoiti KANDA. (Sc.P., I.A.R., F.S., H.I.U. 2, 1941, 217-226, 4 pls. and 8 text-figs.).

*Monostroma zostericola* TILDEN is a green alga which is found growing on *Phyllospadix* in the sea near the authors' Institute of Algological Research in Muroran, Hokkaido. It begins to appear in January and already in the next month the fertile individuals appear and grow luxuriously till June or July, and then the whole disappears.

In the fertile individuals the sporangia are formed at the uppermost margin of the frond, from each of which 8–16 zoospores are liberated. They are round, provided with four cilia anteriorly, and one large chloroplast containing one pyrenoid posteriorly. No eye-spot is present and no phototactic property is recognizable. After germination they undergo repeatedly cell-divisions, till finally a small disc composed of several cells is developed. In summer it remains almost unchanged, but from the end of autumn it gradually increases in size. In December it begins to upheave in its centre. The upheaval grows gradually and is separated from the disc to form a small bullation. After attaining a height of  $\pm 1$  mm the upheaval undergoes splitting in its upper part, which becomes deeper and deeper to form finally several lobes, the caespitose habit of the algae under discussion being due to this process.

*Enteromorpha nana* var. *minima* had formerly been studied by BLINDING, and the authors' results agree with his. In the fertile individuals the zoosporangia liberate 8–16 zoospores, which lack the eye-spot and where no phototactic property is recognizable. They are provided with four cilia anteriorly and many granular chloroplasts posteriorly. After germination they form small discs, on each of which usually one or rarely two or more upheavals are formed, just in the same manner, as we have seen above concerning *Monostroma zostericola*.

In both species under discussion no sexual gametes are formed.

**535. Ueber die Wasseraufnahme und die Keimung von Esosichtensamen in verschiedenen Medien, insbesondere über die spezifische Permeabilität von Harnstoff und Glycerin.** (M. japan. Zfg.). Sennosuke YAMAGUCHI. (B.M.T. 55, 1941, 120–123).

Bei zwei in Hokkaidô weit verbreiteten *Picea*-arten, nämlich, *P. jezoensis* und *P. Glehni*, hat der Verf. die Versuche ausgeführt, um den Einfluss gewisser Elektrolyten und Nichteinktrolyten auf sowohl die Wasseraufnahme als auch auf die Keimung kennen zu lernen.

Erstens, inbezug auf die Wasseraufnahme beim Gebrauch der Elektrolyten ist es vor allem festgestellt, dass die Wasseraufnahme von Samen aus den Salzlösungen kleiner ausfällt bei höherer als bei niederer Konzentration. Bei gleicher Konzentration ist die Wasseraufnahme von Samen grösser aus Na- oder K- als aus Ca- oder Ba-Lösungen. Die Na- oder K-Ionen wirken quellend auf die Samen, um das Eindringen des Wassers und Salzen zu erleichtern, während die Ca- oder Ba-Ionen darüber entquellend wirken, um den Eintritt des Wassers und der Salzen zu hemmen.

Die Salzwirkung auf die Samenkeimung muss auch von einem anderen Gesichtspunkt als die Wasseraufnahme gesondert betrachtet werden, indem die für die Wasseraufnahme von Samen günstigen Salze nicht immer auf die Keimung günstig wirken, so z.B. wirken die Salzlösungen in der Konzentration von 0,1 mol auf die Samenkeimung von *Picea jezoensis* mehr oder minder schädigend,  $K < Mg < Ca < Ba$ , während Na-, Al- und Li-Ionen gar keine hemmende Einwirkung ausüben.

Wenn man die Wirkung des Harnstoffes, Rohrzuckers und Glycerins auf die Keimung von Esosichtensamen untereinander vergleicht, so ist die Grenzkonzentration der Schädigung von *Picea jezoensis* bei Rohrzucker 0,37 mol, bei Harnstoff 0,25 mol. und bei Glycerin 0,8 mol und bei *Picea Glehni* 0,45 mol, 0,3 mol and 0,9 mol. Die oben zitierte hemmende Wirkung des Harnstoffes ist nicht auf den osmotischen Druck zuzuschreiben, da die Samen von Esosichte in 0,4% Harnstofflösung keimen können. Der Verf. glaubt, dass diese hemmende Wirkung des Harnstoffes auf seine grosse Permeabilität und spezifische Giftwirkung zurückzuführen ist. Dagegen ist nach



der Verfs. Ansicht die günstige Wirkung des Glycerins auf seine hohe Permeabilität und seine Ersetzbarkeit des Wassers zu gewissem Grade zuzuschreiben.

**536. Untersuchungen über die vertikalen phototropischen Bewegungen der Laubblätter von *Fatsia japonica* × *P. lateritium*.** Kono YASUI. (Cyt. 11, 1941, 452-463, 22 text-figs.).  
YAMANE. (Jap. J.B. 11, 1941, 305-326, 1 Taf. und 8 Textfig. u. 9 Tab.).

**537. Cytogenetic studies in artificially raised interspecific hybrids of *Papaver* VIII.  $F_1$ -plants of *P. bracteata* × *P. lateritium*.** Kono YASUI. (Cyt. 11, 1941, 452-463, 22 text-figs.).

The hybridization *Papaver bracteata* × *P. lateritium* was performed. The comparison of external features in both parents and  $F_1$  hybrids is shown in a table. Its examination shows that many characters of *P. lateritium* are dominant to those of *P. bracteata*, though some are intermediate between the two parents.

The n-chromosome number is equally 7 in each parent, and consequently in the  $F_1$ -plant the  $2n$ -number is 14.

In the meiosis of PMC in  $F_1$  3-5 pairs of gemini were met with, in some of which the components are unequal in size. Univalents were seen also, which wandered to the poles earlier than the bivalents, and generally 3 or sometimes 2 bivalents were found to form the equatorial plate.

The cytokinesis occurs generally after the first meiosis with several irregularities. Though the second division is pretty regular, good pollen grains were very few in consequence of the irregularities of the first division. The  $F_1$ -plant was highly sterile even after the back-crossing by good pollen grains of the parent plant, whence it is supposed that in the macrosporogenesis the irregularities might be met with, just as in the microsporogenesis.

Finally it may be remarked that the traction fibres were clearly visible in the aceto-carminic smear preparations.

**538. Cyanophyceae of Japan VI.** (With Japanese résumé). Yûichi YONEDA. (A.P.T.G. 10, 1941, 38-53, 4 text-figs.).

The species from the genera *Chroococcus* (2), *Synechocystis* (6), *Chlorogloea* (1), *Myxosarcina* (1), *Xenococcus* (2), *Pleurocapsa* (2), *Chamaesiphon* (1), *Microchaete* (2), *Scytonema* (2), *Nostoc* (3), *Oscillatoria* (5), and *Lyngbya* (1) are enumerated.

**539. Chemical studies on the ether-soluble constituents of mulberry leaves. Part II. Chloroplast pigments.** (Japanese with English résumé). Tokutaro YOSHIDA. (B.I.S.E.S. 10, 1941, 69-115, 4 text-figs. and 46 tables).

The chlorophyll pigment was extracted from fresh mulberry leaves according to the method of F. M. SCHERTZ and J. D. GUTHRIE, somewhat modified by the author. Some results of the quantitative determination of such chlorophyll pigment will be cited below.

The amount of chlorophyll lies between 0.15-0.35% in fresh mulberry leaves, and 0.12% in dried ones, a-chlorophyll being present as much as thrice b-chlorophyll. Carotin 0.1-0.5% of chlorophyll a+b, xanthophyll 1.2-2.2 times as much as carotin.

The amount of chlorophyll in leaves is different according to their respective situation on each branch. Its amount is slightly different according to the time of picking of leaves from morning to evening, and the difference is very insignificant when compared to the difference of the amount of water-soluble carbohydrates in this respect, because they are always considerably rich in the leaves picked in the evening.

The chlorophyll content seems to increase with the development of leaves, and gradually to decrease at the approach of defoliation. In the trees cultivated with the use of fertilizers lacking any one of the elements essential for their growth, the amount of chlorophyll is much reduced, while that of yellow pigments is not affected at all.

An opposite relation exists between the amount of chlorophyll and that of water-soluble carbohydrates, because under well nourished condition of trees the chlorophyll content increases proportionally to the degree of nourishment, while under ill nourished condition, on the contrary, the water-soluble carbohydrates will increase.

**540. Studies on the nature of rice blast resistance I. The effect of silicic acid to the resistance.—II. The effect of combined use of silicic acid and nitrogenous manure to the toughness of the leafblade of rice and its resistance to rice blast.—III. Relation between rice blast resistance and some physical and chemical properties of the different portions of the leafblade of rice.** (Japanese with English résumé). Hazime YOSHII. (B.S., F.T., K.I.U. 9, 1941, 277-307, 19 tables).

The water culture of rice plants was done, and the latter were inoculated artificially by the conidia of *Pyricularia oryzae*. To the nutrient solution various quantities of silicic acid were added, and the degree of resistance to blast disease in various cases was studied. The rate of silicic acid was 0, 50, 250 and 500 mgr  $\text{SiO}_2$  per litre of tap-water. It was observed that the silicic content of the leafblade increases with the quantity of silica given and that the blast disease resistance is proportional to that quantity. The addition of silicic acid to the soil has given the same effect as in water-culture experiment above mentioned.

The effect of combined action of silicic acid and nitrogen manure was studied, and it was observed first of all that the leafblade is richer in silicic acid in the case without nitrogen manure than in that with it.

The toughness of leafblade was measured by the needle puncture method by using JOLLY's spring balance. It was observed that the toughness of leafblade does not increase proportionally to the quantity of silicic acid given, while it is inversely proportional to the quantity of nitrogen manure given, and it is weaker in the culture with nitrogen manure than in that without it.

The author's further experiments have shown that the leafblade is most resistant against the needle puncture of JOLLY's balance at its basal part, and more resistant in its median part than near its tip. The percentage of silica is however larger near the tip than at its basal part.

The author's final conclusion is: "it is evident that the susceptibility of the leaf to the infection of the blast fungus is proportional to the quantity of nitrogen manure, but inversely so to that of silica of the portion of the leafblade, and that there exists scarcely any relation between the blast resistance and the rate of toughness of the leaf portion."

**541. Ecological studies on the vegetation of pastures. Tasiro Pasture in Mt. Hakkôda.** (Japanese with English résumé). Yoshiji YOSHII and Kunizi YOSIOKA. (E.R. 7, 1941, 74-88, 8 text-figs.).

Tasiro Pasture, the well-known fattening pasture in Mt. Hakkôda, 500-1000 m above sea-level, is almost wholly covered by the forest, principally consisting of beeches and oaks, whilst the remaining part (1/10 of the whole area) takes the form of a lawn wholly covered by *Zoysia japonica* which has grown up after the forest trees there

had been cut down. No species of *Sasa* are met with here, which are the commonest undergrowths of the beech forest in this region, and we observe frequently some non-palatable plants, such as *Ilex crenata* and *Carex alba*.

On the margin of the turf, where woods have been cleared away recently, though *Rumex acetosa* comes at first abundantly, the drier part is invaded later by *Zoysia japonica* and passes easily into a lawn. The moisture remains almost unchanged, or even the land is changed into the community with peat-forming plants.

The persistent existence of woodland shrubs, such as *Ilex crenata*, *Rosa polyantha*, *Ligustrum obtusifolium*, *Hydrangea serrata* in the lawn and the invasion of non-palatable plants, such as *Pteridium aquilinum*, *Senecio cannabifolia*, *Dianthus hortensis*, *Salix Reinii* hinder the maintenance of this famous fattening pasture. In the plots which are fenced so as to regulate the grazing, *Miscanthus sinense* and other palatable plants grow abundantly. This will indicate that overgrazing should be guarded carefully in order to maintain the practical value of the pasture.

**542. On the minimum concentration of manganese necessary for the growth of Lemnaceae plants.** (With English résumé). FUJI YOSHIMURA. (B.M.T. 55, 1941, 163-175, 14 text-figs. and 4 tables).

Recently the fact that Mn is essential for the culture of the Lemnaceae has been reported by certain authors. The purpose of the experiments contained in the present paper is to determine the minimum concentration of this element for their bare growth and to observe their behaviour under varying quantities of Mn given.

The materials of the experiments were *Spirodela polyrrhiza*, *Lemna paucicostata* and *L. valdiviana* Phillipi, which were cultured in a dilute KNOP's solution containing Fe and Mn, which has been purified from heavy metal impurities by means of the adsorption method with calcium phosphate.

In the culture solution without Mn or containing it in the concentration of  $10^{-9}$  mol the growth was normal at first, but the fronds remained very small, the growth of roots was extremely retarded, and the chlorosis has set in. By making the concentration of Mn to  $5 \times 10^{-9}$  mol the growth was much better, though the fronds remained still smaller than the normals. The concentration of  $10^{-8}$  mol has led first to the normal growth of *Spirodela*, and it was further seen that the medium with more Mn (e.g.  $10^{-7}$  or  $10^{-6}$  mol) was not specially more favourable for the growth than that of  $10^{-8}$  mol.

As before stated, plants can grow normally for a time even in the solution wholly destitute of Mn, because they contain little Mn in their bodies. The following experiment may be of interest in this respect. Vigorous plants which were thriving in the solution rich in Mn, were killed by heat sterilization, and added to the culture solution without Mn, and then it was observed that the plants therein were able to grow in normal way, evidently on account of the Mn-extract from added plant debris.

Furthermore, it was ascertained that the dry weight of *Spirodela* and *Lemna* in the culture with Mn amounts to 40-300 times as much as in the culture without it.

**543. Studies in the cytology of Pteridophyta XVIII. Spiral structure of the spermatozoid nucleus.** (Japanese with English résumé). AKIRA YUASA. (P.J.S.A.S. 15, 1940, 340-343, 2 text-figs.).

The nucleus of mature spermatozooids in plants are generally stained uniformly and do not show any internal structure. In the present paper the author publishes his results in respect to the spermatozoid nucleus of *Isoetes lacustris*, where its spiral

structure was revealed by means of the ammonia vapour method according to KUWADA and NAKAMURA. Thanks to the employment of this method the spermatozoid nucleus swells up extremely, and consequently its chromonemata are unravelled, and it can clearly recognized that the nucleus is an assemblage of a number of spiral threads. The cilia-bearing portion and the plasma band swell up also independently from the nucleus, which will confirm the fact formerly announced by the author, that these two structures are differentiated from the blepharoplast and are attached externally to the surface of the nucleus to coalesce with it.

The author has tried various other methods for the same purpose, but never succeeded. Nor was his experiment on other ferns successful.

**544. Chromonemata in the life cycle of two species of pteridophytic plants.** (Japanese). Akira YUASA. (B.Z. 9, 1941, 185-193, 56 text-figs.).

The following observations refer to *Adiantum capillus-veneris* and *Pteris multifida*.

In the resting nucleus the spiral thread is always double. In the course of the somatic division these threads begin to cohere firmly to each other and look like a single thread. So also in the metaphase, anaphase, telophase and interkinesis of mitosis its double structure is visible. With the commencement of the reducing division the double structure becomes soon invisible, so that in the diakinesis and metaphase each chromosome consists of two such threads, in each of which rarely the double structure is discernible. The behaviour of chromonemata in the second division agrees with that in somatic division.  $n=24$  and  $40$  in *Adiantum capillus-veneris* and *Pteris multifida* respectively.

**545. Studies in the cytology of Pteridophyta. XXI. On the spermatozoid and spermatoteleosis of *Isoetes japonica*.** (With Japanese résumé). Akira YUASA. (B.M.T. 55, 1941, 112-119, 15 text-figs.).

The spermatozoid of *Isoetes asiatica* is somewhat smaller than that of *I. japonica* formerly studied by the author, but both are similar in their general structure (cf. this JOURNAL 9, (97), No. 330). Each spermatozoid of *I. asiatica* is spiral-shaped with two right-handed spirals. The head is triangular, the outer edge being edged by the border brim. Eight cilia are present, two of which point forwards, and the remaining six rearwards. The cytoplasmic band runs along the whole length of the spermatozoid. The fin-like appendage is seen, which might be the remains of cytoplasm of the spermatid.

In respect to the spermatoteleosis which is in accord with what we observe in many other forms the blepharoplast appears in the cytoplasm of the spermatid, elongates along the surface of the nucleus and differentiates into the border brim and the cilia-bearing portion.













